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**in cooperation with the University of Nebraska, State Soil Survey
Department of the Conservation and Survey Division**

**SOIL SURVEY
OF
NUCKOLLS COUNTY, NEBRASKA**

BY

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COUNTY SURVEYED

Nuckolls County is in the southern tier of counties in Nebraska, just east of the mid-point on the Nebraska-Kansas boundary line. Nelson, the county seat, is about 80 miles in a direct line southwest of Lincoln. The county, which is 24 miles square, comprises an area of 579 square miles, or 370,560 acres.

Nuckolls County is in that part of central Nebraska known by physiographers as the Prairie Plains. Into the original smooth surface of the plain two principal streams, Republican River and Little Blue River, have carved valleys. These streams flow approximately parallel in a southeasterly direction, Little Blue River cutting off the northeastern corner of the county and Republican River the southwestern corner. These valleys separate the upland into three divisions, a large central area between the streams and two small triangular bodies in the corners of the county.

The area lying northeast of Little Blue River Valley includes approximately 60 square miles. Its relief is monotonously even. Not only is the horizon a straight line but the country is a level plain with little variation. Here and there are shallow basins, in which water stands after heavy rains. The smaller of these basins are less than an acre in extent and the larger cover nearly a quarter section, or 160 acres. Near the northeastern corner of the county Northwest Fork Big Sandy Creek, for a distance of 3 miles, has entrenched a flat-floored valley about one-fourth mile wide and from 25 to 40 feet deep.

The area between the Little Blue River and Republican River Valleys varies in width from 14 to about 20 miles. Broadly speaking, it is a dissected plain. The surface consists of a succession of moderately dissected uplands, in which numerous elongated irregular-shaped flats are separated by drainage ways. The maximum relief occurs in the southwestern part and along the belts of hill country which parallel Republican River on the north and Little Blue River on the south. The drainage ways entering these streams from both sides have split the edges of the Nebraska plain into long tongues of flattish upland. Along the headwaters of the smaller drainage ways erosion has been slight but elsewhere, especially along the lower

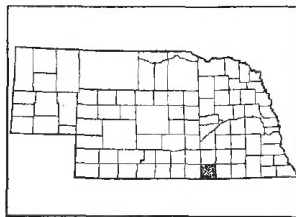


FIGURE 1.—Sketch map showing location of Nuckolls County, Nebr.

courses of some of the streams, the original surface has been completely removed and the bedrock or the underlying sand, gravel, or clay is exposed. Slightly dissected areas also occur in the eastern part of the county, where the few widely separated tributaries of Spring Creek drain the land between Little Blue River and Republican River. The hills of the divide between Little Blue River and Republican River have the characteristic contours of the plain as it appears in a humid region where it has not been exposed to excessive stream cutting. Some of the deeper draws cut through the Niobrara chalk, the soft limestone which forms the principal bedrock of the county.

The larger drainage ways in this division of the county have narrow bottoms or flood plains and terraces along their lower courses. Most of these alluvial strips vary from one-eighth to one-quarter mile in width, but in some places along the larger streams, such as Elk Creek and Spring Creek, they are a half mile or more wide.

The narrow triangular upland strip in the southwestern part includes about 12 square miles of the land in the county. It is dominantly a region of rough hill country with steep slopes which in most places are not precipitous except along hard rock-outcrop areas and river bluffs. The dissection in this division of the county is thorough. The hilltops are either thinly mantled with or are bare of loess, and thick layers of limestone dominate the irregular surface. The most continuous level tracts are the very narrow flood plains which border the small tributaries emptying into Republican River.

This upland is a part of the broad rolling plain which once covered eastern and southern Nebraska. This plain was covered by a massive deposit of loess, a smooth, silty material which in places was more than 100 feet thick. However, the original extensive plain has been altered in many places by the action of water and wind. In places the plain now consists of rounded hills and angular spurs, either entirely composed of loess or capped with that material. In other places the loess cover has been completely removed, and the heterogeneous underlying deposits of sand, silt, clay, and gravel, or bedrock are exposed. In such areas the surface varies from original loess flats to roughest hills composed entirely of bedrock.

The width of Republican River Valley decreases toward the southeast. This valley is flat and lies about 100 feet below the upland level but is flanked by terraces. The valley proper of Little Blue River is a narrow trench, in no place more than a mile and a quarter in width except at its union with tributaries. A mile and a half west of Angus, the valley is less than a quarter of a mile wide. Both flood plains and terraces have developed. In the wider places the terraces are approximately 1 mile wide and occur at several levels above the valley floor. The highest terraces are principally on the south side of the valley. The floor of the flood plains is in general from 80 to 100 feet below the uplands. It lies about 5 or 10 feet above normal water level, and its flat surface is relieved by sandy ridges and abandoned overflow channels.

The average elevation of Nuckolls County is about 1,800 feet above sea level. The general slope of the county is southeastward. The northwestern uplands reach a maximum elevation of slightly

more than 1,900 feet and the southeastern uplands of less than 1,700 feet. The elevations above sea level of several towns are as follows:¹ Lawrence, 1,877 feet; Cadams, 1,783 feet; Nora, 1,754 feet; Ruskin, 1,699 feet; Smyrna, 1,788 feet; Nelson, the county seat, 1,686 feet; Bostwick, 1,603 feet; Superior, 1,576 feet; Hardy, 1,539 feet; Angus, 1,623 feet; and Oak, 1,592 feet.

Nuckolls County was organized on June 27, 1871. Following the great stream of westward migration at the close of the Civil War, the native American population came from eastern Nebraska, Iowa, Illinois, and Ohio, and States as far east as Vermont. A few people came from the South, and a few Danes and Germans came directly from Europe. There is no marked group settlement, although the Danes are settled and somewhat colonized in the east-central part of the county between Ruskin and Hardy, and German settlements are north of Superior.

In 1920 there were in Nuckolls County 8,943 white persons of native parentage, 1,197 foreign-born whites, and 1,813 native whites of foreign parentage. The total population of the county, as reported by the census of 1880, was 4,235. The population has steadily increased and in 1920 numbered 13,236 persons, 2,719 of whom lived in Superior, the only town in the county of more than 2,500 inhabitants. The density of the rural population is 18.2 persons to the square mile. Superior is in the south-central part of the county in the Republican River Valley, 1 mile from the Kansas boundary line. It is on the southern main line of the Chicago, Burlington & Quincy Railroad and is the terminus of several branch lines. Nelson, the county seat, located in the approximate center of the county, had a population of 955 in 1920. Other small towns in the county are Bostwick, located in the southwestern part on Republican River, Hardy, Angus, Oak, and Lawrence. Small trading points with elevator facilities are located in various parts of the county.

About 1890 Superior began to gain importance as a cattle market. At the present time, though still important as a cattle market, grains and dairy products are also shipped from it. A large flour mill is located here.

Nuckolls County is well served by several railroads. The southern main line of the Chicago, Burlington & Quincy, between St. Louis and Denver, follows the Republican River Valley through the county.

The Superior-Edgar branch of the same system leaves the southern main lines at Superior and extends northward. A branch line of the Missouri Pacific Railroad traverses the southwestern corner of the county, and a branch line of the Chicago & North Western Railway enters the county near its northeastern corner and extends southwestward, terminating at Superior. A branch line of the Atchison, Topeka & Santa Fe Railway enters the county from Kansas just southeast of Superior and terminates at that place. The central part of the county is traversed by a branch line of the Chicago, Rock Island & Pacific Railway. The St. Joseph & Grand Island Railway crosses the northeastern corner of the county. All

¹ GANNETT, H. A DICTIONARY OF ALTITUDES IN THE UNITED STATES. (FOURTH EDITION.) U. S. Geol. Survey Bul. 274, 1,072 p. 1908.

parts of the county are within 10 miles of a shipping point, and most farms are within 6 miles of a railroad station.

Most roads, except a few in the bluffs and parts of those which follow the valleys, are on section or land lines. With the exception of 2 miles of concrete road across a sandy stretch southwest of Superior, the rural roads are all of dirt construction. Two State highways cross the county. The main highways between towns are generally graded and dragged after rains. The minor roads receive very little attention, especially in the southwestern uplands, which are sparsely settled, and in other rough and thinly settled sections of the county where the roads run transverse to the drainage ways.

Telephones are in general use and rural-delivery mail routes reach all parts of the county. The rural schools are well distributed over the county. Several of the schools are consolidated, and graded schools are maintained in every town. High schools are located in Superior, Nelson, Bostwick, Hardy, Lawrence, Nora, and Ruskin. The strictly rural churches are few, but churches are conveniently located in the small towns throughout the greater part of the county.

Superior, with its excellent railroad facilities, is the most important shipping point in the county. Nelson, on account of its location in the central part of the county, is an important trading center. Most of the farm products are sold to local dealers. Feeder cattle are generally shipped in from Omaha, St. Joseph, Kansas City, and Denver. Livestock is marketed in Kansas City, St. Joseph, and Omaha. Hogs are shipped mainly from the southern towns. Wheat is delivered to elevators in the various towns. That taken to the northern towns is marketed at Omaha, and most of that taken to the Republican River Valley towns is sent to Kansas City. Dairy products are handled in near-by towns. Dealers in Superior collect the largest quantities of cream for outside markets.

CLIMATE

The climate of Nuckolls County is marked by wide seasonal extremes. The winters are rather long and cold. Summer is the season of heaviest precipitation. The growing season is sufficiently long to mature all crops commonly grown in the county.

The average winter temperature of Nuckolls County, as indicated in Table 1, is 26.4° F., and the average summer temperature is 75.3° F. This is a seasonal range of nearly 50° F. Actual temperatures show a greater variation. The absolute maximum reached was 107° F. in July, and the absolute minimum was -31° F. in February.

About 68 per cent of the annual precipitation of Nuckolls County falls during the period from May to September, inclusive, and almost 70 per cent of this quantity in the hot summer months of June, July, and August. The average annual rainfall of the county, 26.4 inches, is intermediate between that of the regions generally designated as humid and semiarid. This quantity of rainfall has not been so large as to prevent the formation of a zone of lime accumulation in the mature soils of the county. This feature is more fully explained in the part of this report devoted to the discussion of soil characteristics. The average rainfall, when favorably distributed, is generally sufficient for the production of crops whose moisture requirements are not

high. However, the county is subject to considerable range in both quantity and distribution of rainfall. In the driest year on record (1893) there were but 13.99 inches, whereas in the wettest year (1896) there were 41.83 inches of rainfall. The irregular moisture supply constitutes one of the most serious agricultural problems of the county. The frost-free season in Nuckolls County averages 164 days. The average date of the last killing frost is April 25, and that of the first is October 7. The latest recorded killing frost was on May 26, and the earliest was on September 13.

Table 1 shows the average weather over a period of time. The detailed changes occurring from day to day are essential features for observation and record. The most noteworthy characteristic of the climate is the succession of changes which normally occur every three or four days at all seasons of the year. Ordinarily the warm, cloudy, rainy days of summer are followed by short periods of cool, clear, sunshiny days. Winter, with its temperature occasionally falling below zero and its precipitation taking the form of snow, is periodically broken by short periods of warmer, clear, thawing weather, during which practically all the snow is often removed from the ground. The effect of this variation in climate on the farming system is pointed out in the chapter on agriculture.

The summer rainfall occurs largely as local thundershowers so extremely variable in occurrence that it is not uncommon for droughts of a month's duration to occur during the growing season. Usually droughts do not occur during May and June, but during July and August the precipitation may be light and unfavorably distributed. Hailstorms occasionally cause serious damage to crops in some areas.

All seasons of the year are characterized by strong winds, but periods of practically dead calm also occur. The prevailing winter winds are from the northwest, and the summer winds are mainly from the south. The wind movements result in the transfer of fine-grained soil material which is deposited and incorporated with the dust mulch characterizing the predominant soils of the county. The winds are valued as a source of power for pumping but are disadvantageous in that they accelerate evaporation from soils and plants, particularly when strong and hot. The hot desiccating south winds are the most harmful. At periods of their occurrence, the average relative humidity of the county, which ordinarily is low, is reduced to damaging levels, and immature crops are subjected to serious injury. The high winter winds are associated with cold waves and blizzards which pile great drifts of snow along fence rows and in other places. In some years these winds injure winter crops and livestock. The annual snowfall averages 20.8 inches. Country roads are seldom blocked for a long period of time, as the snow does not remain long on the ground.

Table 1, giving the normal monthly, seasonal, and annual temperature and precipitation, is compiled from the records of the Weather Bureau station at Superior.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Superior*

[Elevation, 1,574 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1893)	Total amount for the wettest year (1896)	Snow, average depth
	° F.	° F.	° F.	Inches	Inches	Inches	Inches
December.....	29.9	65	-13	0.69	0.51	0.00	3.4
January.....	24.4	66	-25	.53	.00	.42	3.5
February.....	24.9	83	-31	.91	.00	.14	6.1
Winter.....	26.4	83	-31	2.13	.51	.56	13.0
March.....	37.6	101	-6	.87	.02	1.80	5.2
April.....	51.9	97	5	2.62	Trace.	5.86	.8
May.....	62.1	98	20	3.72	2.35	9.09	.6
Spring.....	50.5	101	-6	7.21	2.37	16.75	6.6
June.....	72.4	103	40	4.33	3.53	2.72	.0
July.....	77.2	107	47	4.42	2.31	5.05	.0
August.....	76.3	104	41	3.02	2.37	6.46	.0
Summer.....	75.3	107	40	11.77	8.21	14.23	.0
September.....	67.8	101	30	2.40	2.03	4.88	.0
October.....	54.4	91	17	2.05	.13	3.98	.3
November.....	40.2	80	-2	.84	.74	1.43	.9
Fall.....	54.1	101	-2	5.29	2.90	10.29	1.2
Year.....	51.6	107	-31	26.40	13.99	41.83	20.8

AGRICULTURE

Agriculture is the most important economic activity in Nuckolls County. The agricultural history of the county begins with that of the Oregon Trail, that great overland route from St. Joseph, Mo., to California. The first settlements, which were attempted in 1858, appeared simultaneously in the Republican River Valley, in the uplands near the present site of Ruskin, and in the Little Blue River Valley. Settlement was not very rapid at first. The first settlers came mainly from the more humid eastern States and from Europe. By the end of 1875 there were more than a thousand permanent settlers, and from that time on the population increased rapidly. By 1889 there were more than 10,000 inhabitants. Settlements soon spread from the lowlands to the uplands.

The early agriculture was limited to the growth of subsistence crops. Sod corn, which was useful as food for both man and beast, was planted in order to obtain a crop at the end of the first year. Later, however, more wheat than corn was raised and the surplus was disposed of to passing immigrants. Spring wheat was the outstanding variety produced. Barley, oats, and rye were among the minor crops. Flax, an excellent crop for new land, was also planted as a cash crop. Later, when troublesome weeds interfered, the growth of this crop was discontinued. Native prairie grasses, growing in pockets on slopes and in areas where soil moisture conditions were good, were cut for hay.

Cattle were allowed to run on the open range during the summer, and some were fed hay and sod corn during the winter. Most of the beef was consumed locally.

Some land was taken up under the tree-claim act, and plots of stunted, gnarled, and dying brush, bushes, and small trees mark the sites of the tree plantings.

For the first 15 years after the settlement of the county, the rainfall was sufficient for agriculture, but three dry years followed in succession. Droughts caused little trouble in the valleys, because here the subsoils were amply supplied with moisture from the high water table. On the uplands, crop yields were so low that some settlers, unable to pay their tax allotment, left the county. Good years were intermittent with bad. Soon after settlement winter wheat was introduced, and since that time it has gradually gained in importance, and the acreage now devoted to spring wheat is small. The construction of a railroad across the northeastern part of the county in 1872 furnished the first opening to outside markets.

In 1880 the average farm comprised 161 acres, more than two-fifths of which was improved. The average value of all farm property was \$1,890. At this time wheat and corn were the principal crops and were grown on practically an equal acreage. Smaller acreages were devoted to the feed grains, oats, barley, and rye.

The large increase in population during the next decade was brought about through the construction of the railroads. The railroad which is now the main line of the Chicago, Burlington & Quincy was extended through Nuckolls County in 1881, and four other railroads entered the county within 10 years. This rapid development resulted in the building of a complete railroad net, serving all parts of the county and so adequate that no new lines have been added.

A few years of good crop yields occurred in the latter part of the decade ended in 1890. During these years weather conditions were especially favorable to corn production and in 1889 the acreage had increased to more than six times the acreage in 1879. The acreage of wheat decreased, but that of oats, which was becoming important as a feed crop, increased to nearly fourteen times the 1879 acreage; and wild hay was cut from twelve times the acreage cut in 1879. At the end of this period the average-sized farm comprised 174 acres; about four-fifths of the farm land was improved; and the number of tenant-operated farms had doubled.

Following this period of rapid settlement came a series of dry years which culminated in the disastrous droughts of 1893 and 1894.

Good years soon followed the bad. The year 1896, three years after the year of minimum rainfall, was the wettest year on record.

The agricultural improvement which now began was owing not only to better climatic conditions but also to the increased experience of the farmers, who began to realize that neither farm methods used nor the variety of crops grown in the humid East were well adapted to this region. New varieties of crops which were introduced or developed were adapted to the low and variable rainfall.

By 1899 the corn acreage had increased to 147,813 acres, the maximum acreage reported by the census. At present the annual acreage in corn averages slightly more than 100,000 acres.

The wheat acreage increased rapidly between 1899 and 1909. Since then it has remained between 50,000 and 75,000 acres.

The acreage in oats has not increased so rapidly as that in wheat. The average annual acreage, over a period of years, is between 20,000 and 30,000 acres. In 1917 more than 50,000 acres were planted to this crop. The acreage in rye decreased from 2,081 acres in 1889 to 46 acres in 1909. In only one or two years since then, notably in 1918 and 1919, has the acreage planted to this crop approximated 1,000 acres. In general, less than 500 acres are planted. With the decrease in rye acreage, the acreage planted to barley has increased. In 1919 barley from 3,616 acres was harvested.

Although the development of a well-adjusted farming system is not complete, the predominant system is modified Corn Belt mixed farming, which consists chiefly of the production of grain and hay for livestock feeding.

The general system of farming just described varies in different parts of the county, depending on the character of the soil and its proximity to markets and transportation facilities. In general, the flat northeastern uplands constitute the wheat-growing section of the county, although corn, small grains, hay, and livestock are produced in various quantities. Most of the cropped acreage in Little Blue River Valley, in the rolling uplands in the central part of the county, and in the Republican River Valley is devoted to corn and hay production. The hilly uplands in the southwestern part of the county, which contain a large proportion of pasture land, are devoted largely to cattle production, although many of the smooth divides and valley bottoms are used for cultivated crops.

Because of the denseness, heaviness, and compactness of their subsoils, most of the soils in the flat upland of Nuckolls County are peculiarly adapted to the production of wheat. The climatic features favor the production of corn, but the compact subsoil layer, or claypan, is unfavorable to the growth of this crop, especially in seasons of scant rainfall. Winter wheat finds this condition tolerable, as its growing period is during the cooler seasons of the year when evaporation is low and soil moisture is fairly high. The level surface facilitates the extensive use of machinery. This is decidedly advantageous, as the farms are large and labor is rather scarce. Corn is the chief summer crop in the wheat section, and oats and hay are the leading secondary crops. Barley, sorghum, millet, Sudan grass, and potatoes are grown on small acreages. Owing to the variable rainfall, wheat yields vary widely. The average annual yields of this and other crops, as reported by the Nebraska State Department of Agriculture, are shown in Table 2.

TABLE 2.—*Acreage and average acre yields of crops in Nuckolls County, 1914-1924*

Crop	1924		1923		1922		1921		1920		1919	
	Acres	Bush.	Acres	Bush.	Acres	Bush.	Acres	Bush.	Acres	Bush.	Acres	Bush.
Corn.....	111,716	23	114,103	23	94,330	15	97,192	25	100,628	34	90,972	17
Winter wheat.....	50,849	17	50,861	9	73,214	13	72,995	16	60,043	17	75,761	15
Spring wheat.....									45	11	926	7
Oats.....	31,287	26	30,091	37	25,062	20	26,916	32	28,480	42	22,337	33
Rye.....	383	17	435	12	479	11	840	16	969	19	1,162	13
Barley.....	1,692	21	5,331	28	3,921	20	3,771	27	5,534	34	3,405	24
	<i>Tons</i>		<i>Tons</i>		<i>Tons</i>		<i>Tons</i>		<i>Tons</i>		<i>Tons</i>	
Wild hay.....	8,694	.8	8,551	1	8,664	.8	8,532	.9	9,424	1	16,630	1.2
Alfalfa.....	17,434	1.6	16,695	2.3	18,513	1.8	20,325	1.6	23,089	2.2	23,434	2.5
Sorghum.....	1,773	3.3	1,585	3.0	1,070	2.3	1,052	2.6	1,640	3.1	7,691	2.9
Millet and Hungarian grass.....	607	2.1	1,089	1.9	443	1.5	430	1.9	448	1.7	612	1.9
Sudan grass.....	2,102	2.1	1,985	2.6	4,146	2.1	1,268	3.0	422	3.0		

TABLE 2.—*Acreage and average acre yields of crops in Nuckolls County, 1914-1924—Continued*

Crop	1918		1917		1916		1915		1914	
	<i>Acres</i>	<i>Bush.</i>	<i>Acres</i>	<i>Bush.</i>	<i>Acres</i>	<i>Bush.</i>	<i>Acres</i>	<i>Bush.</i>	<i>Acres</i>	<i>Bush.</i>
Corn.....	104,704	7	125,717	20	94,390	18.8	92,392	33.5	74,884	17.8
Winter wheat.....	62,082	10	2,856	13	54,336	21.5	68,940	19	65,965	22.5
Spring wheat.....	2,864	7	681	14	48	16	1,641	13	5	18
Oats.....	26,736	12	50,752	27	18,284	36	28,709	30	21,202	43
Rye.....	1,216	9	270	16	84	18.2	427	19.2	209	19.6
Barley.....	5,168	12	3,896	23	476	28.8	270	27.5	177	30.1
Wild hay.....	10,108	.6	12,711	1	9,353	-----	21,732	1.5	8,899	1.1
Alfalfa.....	46,400	1.4	22,394	1.8	597	2.8	22,279	3.5	13,089	3.0
Sorghum.....	1,248	-----	964	-----	570	-----	773	-----	556	-----
Millet and Hungarian grass.....	800	-----	754	-----	349	-----	632	-----	893	-----
Sudan grass.....	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

The corn-producing part of Nuckolls County includes Little Blue River Valley, the rolling central uplands, and the Republican River Valley. The prosperity of this part of the county is in direct proportion to the annual success of the corn crop.

The typical farm outside the Republican and Little Blue River Valleys includes a tract of hill country and narrow strips of flat valley land. Some of the hilly land is suited to farming and some is too rough for any use other than pasture land. The chief grain crops are corn, oats, and barley, and the leading hay crops include alfalfa, wild hay, the sorghums, and sweetclover. All other crops common to the region are grown on smaller acreages. On many farms a small part of the tilled acreage is devoted to winter wheat.

Corn, the leading crop, does well in this section of the county, although yields are not so heavy as in the heart of the Corn Belt. The soils occupying the moderately rolling hills and slope lands lack the dense zone of compaction present in the level upland soils and are consequently more drought resistant and have a somewhat higher moisture content. Owing to the rate of soil erosion on most slopes it is a question whether the cultivation of corn and other plowed crops should continue under the prevailing tillage practices. No soil subject to erosion should be planted to cultivated crops unless it is terraced or fortified by similar protective measures. However, corn ordinarily yields a profit, and its cultivation under prevailing practices seems warranted.

Oats are used chiefly as feed for work animals and are grown on only a small acreage. Some of the grain is sold locally.

The acreage devoted to hay is largely divided among native grasses, alfalfa, Sudan grass, millet, and the grain sorghums, such as kafir. Native hay is usually cut from the slope lands and small drainage bottoms. Alfalfa, owing to its high water requirements, is, like corn, adapted to the upland soils having loose subsoils and a good moisture supply. Most of the land in this section of the county is rich in lime, another advantage in the production of alfalfa. The sorghums and millets are drought-resistant crops. Their inclusion in the rotation is largely a matter of convenience. The rolling areas along drainage ways are usually not cultivated, but they afford fair or good pasturage in favorable seasons.

The system of farming by which land in the Little Blue and Republican River Valleys is managed is very similar to that employed

in the rolling uplands—that is, corn and hay are produced for feeding livestock. These sections of the county are the most favorable for corn production, owing to the proximity of the water table to the surface on the flood plains. The terraces like the uplands, are subject to droughts, except soils which are sandy and retentive of moisture. The chief hay crops of the first bottoms are alfalfa and native grasses. The native grasses are less valuable than alfalfa for hay. Owing partly to susceptibility to overflows and partly to the kind of soil, many areas along the streams are not seeded to alfalfa. Alfalfa yields large and numerous cuttings, where the lime and moisture content of the soil are high. Small grains are not well adapted to the lowlands, owing either to the sandy texture or to the high water table of the soils, but wheat is grown locally as a cash crop, and some farmers plant small acreages of oats and other grains.

Although oats occupy the third largest acreage among the grain crops in the county, they are all consumed locally. In general they are less profitable than other grains, but they are included in the rotation as feed, principally for work animals. Oats do not withstand droughts so well as other grains, as they suffer some damage from hot winds, and, like barley, are subject to damage by grasshoppers.

Both barley and rye are grown on very small acreages, and neither crop has ever been important. Very little of the barley crop is marketed.

According to the State census, between 20,000 and 25,000 cattle of all kinds are kept in the county, the number varying according to the weather and crop conditions. The greatest number of cattle, both beef and dairy animals, are found in a belt paralleling Republican River and lying between this river and Little Blue River. Some purebred cattle are raised in Nuckolls County, but most of the beef cattle are grade Shorthorn and Hereford.

Cattle for feeding are shipped in from Omaha and Kansas City. The animals are pastured and then finished on corn. Nearly every farmer keeps at least one dairy cow, and many keep herds, largely of grade animals, for the production of cream for sale. In 1919 cattle were valued at about \$1,400,000 annually. A few hogs are raised on most farms, but the greatest number are raised in the southern two-thirds of the county, where corn and alfalfa are the leading crops. Where raised in conjunction with cattle feeding, the hogs are generally fattened on corn. On the subirrigated farms of the lowlands or the slope-land farms of the uplands they are either fed on alfalfa or are turned out to sorghum and kafir pasture. Most farmers raise and fatten their own hogs, but some purchase hogs for fattening from local or outside markets.

Purebred sires of the Duroc-Jersey, Hampshire, and Poland China breeds are used to maintain the general high quality of the swine. Hog cholera causes some loss, but outbreaks are not so common nor so disastrous since proper sanitation and vaccination measures have been universally adopted. Hogs are valued at about a quarter of a million dollars annually.

The work animals are mules and horses, principally of the draft type. There are about four times as many horses as mules in the county. Most of the farmers raise their own work animals and sell any surplus locally. Most of the mares are of grade stock, but the sires are purebred Percherons. The average weight of horses is between 1,200 and 1,400 pounds, but some farmers prefer smaller

horses. The average number of work animals to the farm is seven or eight. In the last few years the total number of work animals has decreased to about 9,000 or 10,000 with a total value between \$600,000 and \$700,000.

Every farmer raises more or less poultry, and the sale of poultry products constitutes an important source of farm income. The demand for poultry products is good, and increased attention is being given to the development of this industry. Many varieties of chickens are raised, and many farmers also raise geese, ducks, or turkeys. The total value of all poultry varies from \$600,000 to about \$800,000 annually.

Table 3 shows the number of livestock in Nuckolls County each year from 1914 to 1924, inclusive.

TABLE 3.—*Number of livestock in Nuckolls County, 1914-1924*

Livestock	1924	1923	1922	1921	1920	1919	1918	1917	1916	1915	1914
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
Cattle.....	24,499	23,510	19,421	19,547	21,609	28,110	26,838	28,217	22,113	21,064	20,615
Hogs.....	36,195	40,543	36,623	21,613	19,434	26,943	30,548	25,866	24,099	25,143	20,760
Horses.....	7,504	7,619	6,875	8,019	8,294	8,962	9,267	9,523	8,281	9,304	9,611
Mules.....	1,931	1,972	1,925	1,961	1,728	1,879	2,005	2,342	2,255	2,338	2,180
Sheep and goats ¹	728	1,036	1,015	1,312	1,647	1,338	891	799	1,233	666	573
Poultry.....	<i>Dozen</i>	<i>Dozen</i>	<i>Dozen</i>	<i>Dozen</i>	<i>Dozen</i>	<i>Dozen</i>	<i>Dozen</i>	<i>Dozen</i>	<i>Dozen</i>	<i>Dozen</i>	<i>Dozen</i>
	12,990	12,792	12,255	11,184	10,994	11,409	11,466	10,830	10,001	12,821	6,188

¹ Less than 20 goats in any year.

Most of the hilly uplands of the southwestern part of the county are roughly dissected. The soils are rather shallow and are subject to erosion and gulying when farmed. Here the percentage of soils that may be easily tilled under the predominant regional system of farming is low. Transportation to markets is over rough and hilly roads. Neither the soil nor the relief is adapted to grain farming. This section of the county is predominantly pasture and range land. In some places, however, corn, alfalfa, sorghum, Sudan grass, oats, barley, and other crops common to the region are planted. The system of agriculture practiced here is merely one of producing sufficient feed crops to supplement the pasturage afforded.

Wild grasses, which provide an important part of the hay, are obtained from the upper floors of drainage ways, the dry slopes of rough lands which are not too rough for mowing, and small tracts of valley lowlands which are either too small or too wet for cultivation or are not well adapted to the crop rotation. Among the grasses are bluestem, bunch grass, western wheatgrass, grama grass, and buffalo grass. Yields vary from less than one-fourth ton to more than 1 ton to the acre.

About 20 or 25 per cent of the area of the county is pasture and range land, according to the report of the State department of agriculture in 1922. In the hilly uplands of the southwestern part of the county the proportion of this land to other land is higher than in any other part of the county. Both uplands and valleys are used for range and pasture. Springs and intermittent and perennial streams are fairly abundant, and the lowland ground water furnishes

moisture for the scrubby clumps of elm, ash, and cottonwood. These trees supply shade for the cattle in summer and protection from the wind in winter.

The minor forage crops, including Sudan grass, sorghum, millet, and kafir, are important in this section, which has the greatest percentage of range land, as they have a high feed value, do not require cultivation like corn, yield large hay crops, and are drought resistant.

A few minor crops, such as potatoes, garden vegetables, and fruit, are produced in all parts of the county, mostly for home use. The yield varies widely with the kind of soil and rainfall conditions. In 1918 the average yield of potatoes was only 28 bushels to the acre, but in 1915, a year of good rainfall, it was more than 100 bushels. The truck crops which are grown mainly for home use include water-melons, cantaloupes, tomatoes, and cabbage.

A few small orchards are scattered throughout the county, but little fruit is sold except locally. Apple, cherry, and peach are the most common orchard trees. There are a few pear and plum trees, some grapevines, and some small fruits, mainly strawberries. Fruit, in general, has proved unprofitable, owing to unfavorable climatic conditions, and the number of orchards is decreasing.

The preceding paragraphs have indicated the regional distribution of the principal crops. The adaptation of certain soils to particular crops is not observed by all farmers. However, some local adjustment of crops to soil and surface relief is made. Wheat is usually grown on the smooth, level parts of the Hastings and Holdrege soils, corn on level or rolling areas of the Hastings, Holdrege, Nuckolls, and Valentine soils, and on all terrace and bottom lands, and alfalfa on subirrigated bottoms, terraces, and rolling moist limy hill lands of the Cass, Sarpy, Lamoure, Hall, Waukesha, and Holdrege series. Fields on northern slopes are usually considered the best for corn, and those on southern slopes are better adapted to wheat and the fine-rooted, drought-resistant sorghums, millets, and kafirs. Many farmers disregard the location of crops, although in dry seasons corn and other crops produce better yields on the rounded slopes and northward-facing valley sides than on the flatter uplands or slope land with a southern exposure. Practically no farming is done on the badly eroded drainage-way slopes, which are suitable only for grazing. The wet and sandy bottom lands are used for pasture and for hay production.

Alfalfa is planted extensively on much of the bottom land of Republican River and Little Blue River and of many of the larger tributaries of these streams where subsoil moisture conditions are favorable. Alfalfa can not stand swampy conditions and does not thrive in sandy soils, but wherever texture and ground water are favorable, it produces well. The heavy, well-drained bottom soils of the Wabash series which are not planted to alfalfa are better adapted to corn than to small grains. Small grains often produce a rank vegetative growth at the expense of the grain, and there is also danger of lodging.

Modified cultural methods not practiced in the more humid parts of the State are employed by many farmers in the care of the principal crops. In general, systematic crop rotations have neither been worked out nor consistently followed. Agriculture may be said still to be in its youth or pioneer stage. The best methods have not

been proved, as they have been in the older settled regions of the State and the United States. This lack of proved methods is largely owing to occasional droughty seasons, which make adherence to a definite plan practically impossible with the present system of agriculture.

The most common crop rotation used in Nuckolls County at present is corn for two years followed by wheat or oats. Barley may enter the rotation, and now and then, alfalfa. Alfalfa is sometimes left as long as there is a good stand.

Commercial fertilizers are very seldom used. Some farmers apply manure to the land, but generally manure is used only in fields near the barnyard. Some farmers maintain that the application of manure is harmful to grain, as the abundant rainfall in the early part of the season causes the growth of a large, bulky plant structure and little grain where the land has been manured. In general, little attention has been given to maintaining soil fertility. Where economic conditions force the cultivation of exceedingly rough lands, such as Holdrege silt loam, rolling phase, the application of barnyard manure and the growing and plowing under of legumes and other cover crops is advisable.

As a rule, the farms are moderately well improved. The farm buildings throughout the larger part of the area are substantial and reasonably up-to-date and are well painted and in good repair. Hog yards are fenced with woven wire, and most of the farmsteads are fenced and cross fenced with barbed wire. Some whole farms are inclosed by hog-tight woven-wire fencing. In many places a clump of trees marks the site of a homestead.

Modern labor-saving machinery, including riding cultivators, plows, grain drills, disks, binders, rakes, harrows, and mowers, is in general use. On the larger farms the equipment is more extensive. Gas engines are used by many farmers, but gas tractors are not common. In 1924, 810 gas engines, 65 tractors, and 18 trucks were reported on farms in the county. Automobiles are in common use for transportation and light marketing. The census reported 1,252 automobiles, about one to each rural family, on farms in the county. About 79 silos provided storage for forage crops. Within the home cream separators and other labor-saving appliances are common.

The supply of labor is usually adequate and fairly efficient. The usual wage paid a single man is about \$45 a month, with board and laundry, but occasionally as much as \$60 a month is paid. A man with a family is paid about \$50 a month. He boards himself but has the use of a house, a chicken yard, and a garden plot, and a cow, pigs, fuel, and certain fresh meat may be furnished. Day laborers are paid \$3 or \$3.50 during the harvest season and so much a bushel for corn husking. Eight cents a bushel is paid for threshing wheat and 6 cents for oats. Except in busy seasons, most of the farm work is done by the farmer and his family or by exchange of labor among neighbors.

In Nuckolls County in 1922 there were 1,543 farms, averaging about 235 acres each. The State census reports that in 1922, 36 per cent of the area of the county was occupied by owners and almost two-thirds by tenants. The percentage of tenancy exceeds that of the State as a whole. Cash rent was paid for 28.4 per cent of the rented acreage, and 71.6 per cent was worked on shares.

According to the Federal census, 79 per cent of the area in farms in 1920 was improved. The average farm had a value of \$26,930, of which 77.5 per cent represented land, 10 per cent buildings, 4.3 per cent implements, and 8.2 per cent domestic animals. The average land value was \$100.10 an acre, but the range was from \$10 to \$150 an acre depending on the surface relief, character of the soils, improvements, and location with respect to markets. The labor expense on the 68.9 per cent of the farms reporting in 1919 was \$367.89 to the farm. The purchase of feed, averaging \$678.14 to the farm, was reported by 75.2 per cent of the farmers. The expense for both feed and labor increased in the decade 1909 to 1919.

In 1922 slightly more than three-fifths of the total area of the county was under cultivation and more than one-fifth of the remainder was pasture and hay land. No land in the county is under irrigation.

SOILS

Soils differ widely in such properties as color and other important physical and chemical characteristics. Examination of most soils show that they are composed of layers, each of which can be recognized on several bases, such as color, structure, degree of compaction, texture, and other features. In some soils the same color is persistent through several structural or textural layers, whereas other soils show great color variation without much change in texture. The succession or arrangement of these layers, when viewed in vertical cross section, is termed the soil profile or soil section, and it is common practice in soil studies to group the soils according to their profiles with reference to color, texture, structure, degree of compaction, and other characteristics.

The normally developed soils of Nuckolls County, such as those on the gently rolling or nearly level upland, are characterized by three principal characteristics: (1) The dark color of the topsoil, which persists throughout the soils of the county and which results largely from the accumulation of organic matter derived from the annual decay of grasses; (2) the presence in the subsoil of a layer of lime accumulation, where the limy material from other parts of the soil has concentrated; and (3) the more or less granular structure of the topsoils and the cloddy or nut structure in the lower soil layers. Most of the soils in Nuckolls County, with the exception of the sandy soils, have developed these characteristics to a greater or less degree.

Soils whose profiles have certain fundamental characteristics in common may for convenience be classified and discussed as a group. The characteristics of the soils of Nuckolls County correspond in a broad way to the main features of the surface relief. The soils may be grouped, therefore, according to the relief of the districts in which each group is found. For convenience the nomenclature used is topographical rather than pedological, but it refers in reality to the different characteristics of the soils rather than merely to the relief. The soils may be grouped into those occurring on the smooth uplands and terraces, those occupying the rolling hilly lands, and those lying on the first bottoms or flood plains. Owing to the fact that the climate and vegetation of the smooth uplands and the hilly uplands are practically identical, the chief differences developed in these groups of soils are the result of differences in relief.

The most extensive soils in Nuckolls County are those which occupy the flat or gently undulating uplands and terraces, the smooth level stream divides, and associated gentle slope lands. These soils have been comparatively undisturbed for a long period of time as far as soil-forming processes are concerned and are consequently fairly well developed. Both surface and underdrainage are inadequate in some places, but the soils have acquired certain significant features in common.

These soils, in their natural or uncultivated state, have fairly well-developed profiles which normally show five layers. The upper layer is generally a grayish-brown structureless dust mulch which varies from a mere film to several inches in thickness and from silty very fine sandy loam to silt loam in texture. It is underlain by a platy or laminated layer which is made up of small disks or platelike forms overlapping one another horizontally. This layer varies in thickness from 1 to 6 inches, and its characteristic color is very dark grayish brown.

The third layer ranges from less than 1 foot to more than 2 feet in thickness and is characterized by the granular structure and arrangement of the soil particles or aggregates. These granules are irregular units ranging from less than one-eighth to slightly more than one-fourth inch in diameter. The layer contains less organic material to the unit of soil volume than the one above, although it appears almost as dark, especially in its upper part. This feature is owing to the fact that the organic constituents are not thoroughly mixed with the soil mass, as in the overlying layers, but occur chiefly as a film or coating on the surface of the granules. The film is thickest over the granules near the top of the layer and becomes thinner with depth. The fourth is the layer of maximum compaction. This layer is denser, heavier, and more compact than any other. It varies in color from grayish brown to dense black and may be practically structureless or have a tendency to break into units, more or less uniform in size and shape. Furthermore, the material may vary greatly in density, the compaction being scarcely noticeable in some localities and so pronounced in others that the material resembles a claypan. The lowest, or fifth layer of the soil proper, is the layer of lime accumulation. The material of which it is composed is commonly light-brown or very light grayish-brown silt rich in lime. The calcareous material is present either as soft or hard concretions, but many spots and splotches of white lime occur throughout the mass. This layer is generally structureless and breaks readily into soft, angular clods of various sizes and shapes.

The layer of lime accumulation is underlain by the loose parent material, most of which does not contain a noticeable quantity of lime to a depth of 4 or 5 feet. In places where lime is present in the parent material, however, it is invariably less abundant to the unit of soil volume than in the lime layer. The parent material is designated as loess in the State geological surveys.

The group of smooth upland and terrace soils includes eight soil series, the Holdrege, Hastings, Crete, Butler, and Fillmore of the smooth uplands, the Hall and Waukesha of the nearly level terraces, and the Judson of gentle colluvial slopes. All these soils have friable, dark-colored topsoils, and most of them have upper subsoil layers which are more compact than any other layer and lower subsoil

layers which are rich in lime. The prevailing features, however, are not equally developed in all of the series. For instance, in the Hall, Holdrege, and Hastings soils the upper subsoil layers are not so extremely compact as in soils of the Crete, Butler, and Fillmore series. The upper subsoil layers of the Crete soils are brown, and the corresponding layer in the Fillmore and Butler soils is black. The upper subsoil layers of the Hastings soils are more compact than those of the Holdrege but are less dense than those of the Crete.

The Hall, Waukesha, and Judson soils have developed over the better drained alluvial and colluvial deposits. The Hall soils occur on the higher terraces and have a profile similar to that of the Holdrege soils, except that the subsoil layers are slightly more compact. The Waukesha soils differ from the Hall in that their lower subsoil layers contain much less lime. The Judson soils, developed over loose, newly laid alluvial and colluvial deposits, are almost structureless and are uniform in texture to a depth of 3 or more feet. In Nuckolls County the silt loam members of the Hall and Waukesha series and the silt loam and very fine sandy loam members of the Judson series are mapped.

Soils of the Scott series occupy depressed and poorly drained areas in the more level upland. Excessive moisture has prevented the development of a normal soil profile. The surface soil is almost black, but in its lower part there may be a sprinkling of white or a well-marked white layer. The subsoil is heavy dark-gray structureless clay, which continues to a depth of 5 feet or more, where it is underlain by the parent loess. No lime layer has developed in this soil. Scott silt loam is mapped.

The rolling hill-land soils have certain characteristics in common with the smooth upland and terrace soils, because they have developed under the same vegetal and climatic conditions. However, the rolling or hilly relief has caused the development of profile characteristics which differ from those of the smooth upland and terrace soils. The rolling hill-land soils are widespread, being associated with nearly every large drainage way in Nuckolls County. Soils of the Nuckolls and Sogn series are included in this group.

The Nuckolls soils occupy gentle or steep slopes, hill shoulders, and narrow spurs in many of the valleys of the county. The parent material over which these soils have developed is known in the Nebraska geological survey as the Loveland phase of the loess. The profile developed is similar to that of the Hastings soils but differs in that both soil and parent material have a reddish color. One member of this series, Nuckolls silt loam, is mapped.

The Sogn soils occupy very rugged areas, and the profiles are very immature. These soils have not developed such well-defined layers as have soils of the smooth upland. The parent material consists mainly of a calcareous formation known as Niobrara chalk, with a thin covering of silty material derived from the loess. The topsoils are dark colored but are very thin. The subsoils, which are light grayish brown, overlie the parent limerock at a slight depth. Only the silt loam of this series is mapped.

The gravelly hills, which have been mapped as rough stony land, and Valentine loamy sand may also be regarded as belonging to the rolling hill-land group.

The material from which the flood-plain soils are developing has in most places been recently deposited and the soils are consequently

very immature. The parent materials of the flood-plain soils include both coarse and fine sediments. The soils composed of sediments deposited some time ago have more or less well-defined soil profiles. The characteristics of soils in this group, however, vary widely. Four series of flood-plain soils, the Cass, Sarpy, Wabash, and Lamoure, have been mapped in Nuckolls County.

The sandy soils are included in two series, the Cass and Sarpy. The Cass soils have accumulated fairly large quantities of organic matter in their surface layers and are consequently dark grayish brown. The subsoils, however, do not contain much organic matter. They are not only lighter in color than the topsoil but are also coarser in texture. They are stained with rust-brown specks and splotches and are usually composed of alternating layers of coarse and fine materials. The topsoil is only locally calcareous, but the typical subsoil has a high lime content. Four members of the Cass series, the silty clay loam, silt loam, very fine sandy loam, and sandy loam, have been mapped.

The younger soils of the sandy group, included in the Sarpy series, have light-colored surface soils. In all other respects, except their generally somewhat coarser texture, they are practically identical with the Cass soils. Most of the Sarpy soils occur in recently overflowed areas. The deposits which have formed them have been so recently laid down that most of the soil is composed merely of the alternating layers deposited by the streams. Sarpy loamy sand and Sarpy gravelly sandy loam are mapped.

The fine-textured alluvial deposits have given rise to soils of the Lamoure and Wabash series. Soils of both series have dark grayish-brown or black topsoils which are underlain by heavier, more compact but dark-colored subsoils. The lower layers are mottled with iron stains and gray splotches. Underdrainage is inadequate, but between overflows surface drainage is adequate. Soils of the Lamoure series have subsoils which vary from grayish brown to mottled gray or yellowish gray and which, as a rule, are heavier in texture than the surface layers. The subsoils are highly calcareous, and in some places the topsoils may show lime reaction. Only the silt loam member of the Lamoure series is mapped in Nuckolls County.

Soils of the Wabash series are similar to those of the Lamoure, except that they contain no lime. The Wabash soils occur on the flood plains of both large and small drainage ways. The series is represented in Nuckolls County by Wabash silty clay loam and Wabash silt loam, light-subsoil phase.

Five soil-influencing elements are recognized in the development of any soil. They are the parent material from which the soil is derived, the climate of the region in which the soil is developed, the natural vegetation under which the soil is formed, the surface relief of the land, and the native animal life in the soil. The most extensive soil-forming material in Nuckolls County is the well-known gray upland loess which covers a large part of central, southern, and eastern Nebraska. The loess is a light-colored gray formation which deeply mantles the older soil materials and which formed, at the time of its deposition, a smooth, more or less level, plain. It varies in thickness from a thin mantle to a massive deposit. It is thickest on the flat, imperceptibly dissected areas and is merely a thin coating on the bluffs,

hills, and stream slopes. The loess material is largely silt with a very small admixture of very fine sand and clay. It is fairly rich in lime, which is disseminated throughout the mass as finely divided particles, splotches, and concretions. On steep slopes and bluffs the color is typically buff or yellowish brown, owing to the presence of finely disseminated oxide of iron. In its unweathered state, however, the loess material is gray, light yellowish brown, or very light grayish brown. Where not exposed on steep banks or deep cuts, it is structureless, breaking down into soft, irregular clods. Along drainage ways, road cuts, and other vertically exposed areas, however, the loess is inclined to split into small, upright columns. This feature causes the striking bluff formations seen along the larger streams. Under the processes of soil formation this gray loess has undergone marked chemical and physical changes. It has given rise to a number of soils whose fundamental characteristics differ, depending on location. This upland loess has given rise to soils of the Holdrege, Hastings, Crete, Butler, Fillmore, and Scott series.

The second largest soil-forming material of the area is the so-called valley loess. This formation is very similar to the gray upland loess, especially in its major characteristics. It is presumed to be a valley-filling deposit which has been carried in by streams in comparatively recent times but subsequent to the deposition of upland loess. The material is mainly light-gray or light yellowish-gray silt. The Hall, Waukesha, and Judson soils are derived wholly or in part from valley loess.

The gray upland loess is underlain by an older formation of slight thickness which State surveyors have designated as the Loveland phase of the loess. This is pale-red sandy clay material which is partly exposed in many of the valleys, where it forms reddish strips of land. It is also noticeable in well borings and deep excavations. The soils derived from this deposit are grouped in the Nuckolls series.

Here and there within the county are outcrops of sand and gravel, appearing as small areas of coarse sand or as rounded cobble-surfaced hills and slope lands. They occur principally along drainage ways where the overlying loess mantles have been washed away. Beds of these materials are thought to underlie most of the gray loess. The chief source of water supply in the uplands is within these beds. The sand areas are classed in the Valentine series and the cobble-surfaced hills as rough stony land.

Underlying the entire county is the Niobrara chalk and other limy and shaly formations. Erosion has exposed these rocks intermittently in bluffs and slope lands along Republican River, the lower parts of some of its major tributaries, Little Blue River, and a few scattered drainage ways. Where weathering has been active and erosion not too rapid, these inextensive areas are classified in the Sogn series.

The youngest soil-forming materials in Nuckolls County are along the first bottoms of the streams. They are merely deposits of stratified and partly stratified sand, clay, and silt, which are water sorted and laid down by stream action under usual flood-plain conditions. Owing to the physiographic process by which the material was laid down, both areal and vertical distribution of the deposits are without marked sequence or order, particularly in the Republican River Valley. The small upland streams, flowing through areas of loess or

sand only, deposited fine-textured, silty material or coarse material respectively. Soils along them are consequently more uniform than along the larger streams.

The soils derived from alluvial materials are classed in the Sarpy, Cass, Lamoure, and Wabash series. The Cass and Sarpy soils are associated with the sandy flood-plain materials, and the Lamoure and Wabash were derived mainly from clay and silt sediments.

Climate influences the temperature and moisture conditions under which the parent material is transformed into soil. The climate of Nuckolls County is transitional between that of the humid East and the semiarid West. Although the rainfall has not been sufficient to thoroughly leach the readily soluble lime from the entire soil, as it has in regions farther east, it has removed it from the upper soil layers to a lower one, thereby producing a layer of lime accumulation in the lower part of the subsoil. The climate has favored the accumulation and retention of unusually large quantities of organic matter or decayed plant remains, which have made the soils throughout most of the county as fertile as those in regions of much higher rainfall.

The natural vegetation under which a soil is formed influences not only the soil color but also the structure and chemical composition. It is believed that the color is largely imparted by the finely divided organic material which has been derived mainly from decayed grass roots. This material is more or less mingled with the mineral matter of the soil and the dark color is the result. The natural vegetation of Nuckolls County is of the tall-grass type. The organic matter derived from this vegetable mantle has been incorporated to a greater or less extent in the upper layers of the normal soils of the county and forms a coating, decreasing in thickness with depth, on the structure particles of the underlying layers. The upper layers are either dark grayish brown, dark brown, or very dark grayish brown, and the granular and compact layers are brown or grayish brown. The high content of organic matter has rendered the soils of Nuckolls County very fertile and of good structure.

The surface relief also has its influence on soil stability, susceptibility to erosion, and drainage conditions. The depressed areas in which water stands after every rain are poorly drained throughout, owing to the fact that the surface water has its only outlet downward. On some steep slopes where the run-off is excessive leaching is so rapid that most of the plant-food elements are removed as rapidly as they are formed.

Nuckolls County has a varied surface relief, the land ranging in configuration from flat and depressed to hilly and steeply rolling. Consequently a wide variation of soil characteristics is present. The Holdrege, Hastings, Crete, Fillmore, Butler, Scott, Hall, Waukesha, and Judson soils are nearly level. Members of the Hastings, Crete, Hall, Waukesha, and Judson series have sufficient slope to afford good surface drainage. The Butler, Fillmore, and Scott soils, however, occupy practically level or slightly depressed areas, and drainage is not so well developed. The Sogn, Nuckolls, and Holdrege soils occur on steep rolling land.

Another group of smooth-land soils occupies first bottoms or flood plains and includes members of the Cass, Sarpy, Wabash, and Lamoure series.

Worms, insects, and other borers in the soil are common. Their presence in and their movement through the soil have had an effect on both the chemical constituents and the physical structure of the soil mass. Organic and mineral materials from the upper layers penetrate to a lower depth along openings made by the borers. The effect of various microorganisms on soil formation is a subject of extensive investigation.

In the following pages of this report the soil types are described in detail and their relation to agriculture is discussed. The accompanying map shows their distribution in the county. Table 4 gives the name, the acreage, and the proportionate extent of each soil type mapped.

TABLE 4.—*Acreage and proportionate extent of soils mapped in Nuckolls County, Nebr.*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Crete silt loam.....	153,928	42.3	Cass sandy loam.....	512	0.1
Holdrege silt loam, rolling phase.....	125,888	34.0	Nuckolls silt loam.....	22,272	6.0
Waukesha silt loam.....	14,272	3.9	Butler silt loam.....	3,712	1.0
Hastings silt loam.....	6,912	1.9	Fillmore silt loam.....	1,280	.3
Hall silt loam.....	4,416	1.2	Valentine loamy sand.....	640	.2
Judson silt loam.....	3,520	.9	Sarpy loamy sand.....	4,096	1.1
Judson very fine sandy loam.....	2,560	.7	Sarpy gravelly sandy loam.....	128	.1
Wabash silt loam, light-subsoil phase.....	3,832	2.4	Sogn silt loam.....	512	.1
Wabash silty clay loam.....	4,256	1.1	Lamoure silt loam.....	192	.1
Cass silt loam.....	4,256	1.2	Scott silt loam.....	448	.1
Cass very fine sandy loam.....	6,720	1.8	Rough stony land.....	832	.2
Cass silty clay loam.....	1,844	.3	Total.....	370,560	----

CRETE SILT LOAM

Crete silt loam is a dark-colored upland soil, readily identified by the brownish color and compact, claypanlike structure of its upper subsoil layer.

This soil, under native sod, is composed of five well-defined layers. The upper three, which comprise the topsoil, are rich in organic matter and are dark colored, ranging from dark grayish brown to almost black. They are friable, have a combined thickness of about 20 inches, and include a surface mulch, a laminated layer, and a granular layer. The surface mulch varies from one-half inch to 2 inches in thickness. It is silt loam, dustlike when dry, and consists of a loose mixture of silt and very fine sand particles, together with an abundance of plant roots and leaves. Most of the vegetal material is sufficiently decomposed to give the mulchlike covering a dark grayish-brown color.

The second layer is about 3 inches thick and is composed of the same mixture of ingredients as the first, but the vegetal material is well decomposed, giving the layer a very dark grayish-brown or almost black color. The soil material is not loosely arranged, as in the surface mulch, but is grouped in thin, horizontal, and wedge-shaped forms which overlap one another, giving a layer a platy appearance. In cultivated fields the two upper layers become mixed and pulverized through tillage operations. Their former presence, however, is largely responsible for the mellowness, high fertility, and favorable tilth of the soil.

The third layer of the topsoil, the granular layer, is from 14 to 18 inches thick. It is friable but moderately heavy silt loam, similar to, or only slightly lighter in color than, the laminated layer. The soil particles are granular or small, irregular, more or less angular forms from one-eighth to one-fourth inch in diameter. The small granules are most abundant in the upper part of the layer. The organic matter is not uniformly mixed with the mineral soil particles, as it is in the overlying layers, but occurs chiefly as a film or coating on the surface of the granules. The film decreases in thickness with depth. Owing to the peculiar distribution of the organic matter the true color of the granular layer can be obtained only by mixing the lighter colored interior of the granules with the dark exterior coating. The resultant color is somewhat lighter than that of a freshly broken surface and is decidedly lighter than crushed material from the laminated layer. This layer contains less organic matter to the unit of volume than does the overlying laminated layer. Its greater thickness, however, renders it the chief reservoir of available food and moisture for the common cereal crops.

The subsoil of Crete silt loam consists of two layers, the upper of which is a claypan lying immediately below the granular layer and continuing to an average depth of 40 inches. It is decidedly brown, is composed largely of clay, is plastic when wet, and is very hard and tough when dry. The material breaks into irregular clods of various sizes. The layer is readily identified by its compact claypanlike structure and is known by the farmers as the brown gumbo layer. The brownish color is imparted by a very thin organic-matter film which covers the clods. A lump of the claypan, when pulverized, becomes light grayish brown. Exposures of this layer in dry road cuts present a coarse network of fine seams and cracks resulting from the shrinkage of the clay. The claypan greatly retards water movement and is extremely resistant to penetration.

The lower subsoil layer is one of lime accumulation. It is about 30 inches thick and is composed largely of loose, floury, light-gray silt which may be somewhat compact and slightly darker in color in the upper part where it joins the claypan. The lime occurs in specks, splotches, and small hard or semihard concretions, especially in the upper part of the layer. The content of lime decreases with depth although finely divided powderlike lime, which is uniformly mixed with the silt, continues to a depth of about 70 inches.

Beneath the lime layer is the formation from which the soil has weathered. It is yellowish-gray, loose, floury, and columnar silt locally called yellow clay but known by geologists as loess. It is very uniform in its composition to a great depth and is exposed in many deep road cuts or severely eroded hillsides throughout the uplands. The loess contains no lime to a depth greater than 15 or 20 feet.

The topsoil of Crete silt loam is fairly uniform in Nuckolls County. The upper part of the subsoil, or the claypan layer, however, varies somewhat in density, color, and structure in different localities. In some areas it is a little more friable than typical, is faintly columnar, and has a tendency to break into more or less prismatic clods where the soil borders areas of Hastings silt loam. Bordering areas of Fillmore silt loam, Butler silt loam, or Scott silt loam, however, the claypan is slightly darker than typical. These variations are local and unimportant and are not shown on the soil map.

Crete silt loam is the predominant soil throughout the more level uplands in Nuckolls County. It occupies 42.3 per cent of the total area of the county and occurs in nearly all parts. Areas are flat or gently undulating. In few places does the soil extend more than a short distance down valley slopes, except where the slope is very gradual. Most of the surface is nearly level and is characterized by scattered basinlike depressions in which occur Fillmore, Butler, and Scott soils. Drainage channels are poorly developed, but as the soil occupies the highest positions in the county the slope is commonly sufficient to remove the surplus surface moisture.

All crops common to the region are grown on this soil, but as the supply of readily available soil moisture is limited to that part of the soil above the claypan layer, small grains succeed better than corn or alfalfa. Wheat succeeds especially well on this soil, as it matures before the hot, dry weather of midsummer. The acreage devoted to wheat is probably 10 or 15 per cent larger than that in corn. Crop yields depend largely on the rainfall and the care used in managing the soil. During normal years the land is as productive as any of the upland soils in the county, but in dry seasons corn and alfalfa especially suffer from lack of moisture.

The usual yield of wheat is about 15 bushels to the acre, but the range is from less than 8 bushels in unusually dry seasons to 25 or 30 bushels in years of high precipitation. Corn yields from 5 to 30 bushels to the acre, averaging about 25 bushels. The average yield of oats is about the same as that of corn, and alfalfa yields from one-half to 2 tons to the acre.

The soil is easily managed, in spite of its fine silty texture. Clods form if it is plowed when wet, but the lumps are easily reduced, and the surface soil can be kept in good tilth with ordinary care. This soil is naturally strong and fertile and in years of average precipitation equals Hastings silt loam in productiveness. Crop yields, however, are more affected by a decrease in rainfall than on Hastings silt loam, because of the more limited water-storing capacity of the Crete soil.

The current selling price of Crete silt loam ranges from \$80 to \$140 an acre, depending on location and improvements.

HOLDREGE SILT LOAM, ROLLING PHASE

The topsoil of Holdrege silt loam, rolling phase, is loose friable silt loam, 12 or 15 inches thick. To a depth of 6 or 7 inches the soil is dark grayish brown or grayish brown and is practically structureless. The remainder of the topsoil is grayish-brown silt loam, slightly more coherent than the overlying material and faintly granular. The granules, however, are vague in outline and are very small, few of them exceeding one-eighth inch in diameter. They are almost round or sub-angular. The subsoil is gray or light grayish-yellow silt loam or very fine sandy loam, extremely friable and having the smooth, floury feel characteristic of loess. It is highly calcareous, the lime occurring in the form of small concretions. The material is also mottled with brownish iron stains. The subsoil is underlain, at a depth of about 40 inches, by the unweathered loess parent material. The loess is friable, grayish-yellow or grayish-brown silt loam. It is uniformly fine in texture and is calcareous but contains no pronounced concretions. Rust-brown stains are numerous below a depth of 5 feet.

Holdrege silt loam, rolling phase, is characterized by its extremely light color and high lime content. In open cuts and banks lower layers of the soil show the characteristic columnar form so common to loess formations. Throughout most of this soil in Nuckolls County, the surface soil is noncalcareous, as the rainfall has been sufficient to leach the lime into the lower layers.

Holdrege silt loam, rolling phase, is fairly uniform throughout the county. In places, the topsoil is very nearly very fine sandy loam in texture, but in the rough rolling uplands, where erosion is excessive, it is very heavy silt loam or silty clay loam. On long, gentle slopes, the soil is generally fairly deep, continuing, in some places, to a depth of nearly 20 inches. On eroded bluffs and slopes, however, the surface layers are thin and grade almost immediately either into the parent loess or the lower subsoil layer. The topsoil, in the more nearly level areas, is well supplied with organic matter, compared with the amount in the rougher situations.

The floors of the many drainage ways which ramify this soil are mantled with colluvial wash and alluvial materials but are included in mapped areas of Holdrege silt loam, rolling phase, because they were too narrow to be shown on the map.

Except where the grass cover has not been removed, this soil, owing to its topographic position, has not developed the same characteristics as the associated Hastings and Crete soils of the uplands, although it has weathered from similar parent material. It has developed on rolling or steeply rolling hill land. As a whole the rugged surface has favored erosion and thus prevented the soil from reaching maturity.

Holdrege silt loam, rolling phase, ranks second in area among the upland soils of Nuckolls County. It occurs adjacent to and in the valleys of the drainage ways which empty into Republican River from the southwestern hilly uplands, where erosion has destroyed the flat surface. It also occurs on slopes and bluff lands and borders the headwater drainage of small streams in the central rolling uplands. It is rather extensive along the short drainage ways leading to Little Blue River and along the slope and bluff lands of Little Blue River Valley.

The areas are fairly large but are very irregular. The soil occurs principally as narrow strips, flanking the narrow valleys. In the hilly uplands in the southwestern part of the county the soil occurs on the minor divides of branching tributaries and covers many of the sharper ridges adjacent to the drainage basins.

The surface of this soil ranges from almost level over small areas to steeply sloping, eroded, and blufflike. The level areas are on the smaller divides between close-lying drainage ways. The narrow strips along the stream valleys are characterized by moderate or steep slopes and are rather deeply eroded in places. On the steeper slopes, the uneven surface makes plowing and harvesting of crops rather difficult and detracts from the agricultural value of the land. Along the large drainage ways, especially Republican River and Little Blue River, and along the lower courses of some of the drainage ways emptying into these larger streams, the land is rolling or rough, with short steep slopes and precipitous bluffs. The streams have in places cut deep, abrupt, perpendicular-walled valleys into the originally level upland surface. Miniature landslides are more or

less common, and in many places the slopes present a succession of steps.

Owing to the topographic position, drainage of both topsoil and subsoil is adequate. The subsoil retains moisture remarkably well. This characteristic renders the soil an excellent one for corn, and crop failures from lack of moisture are never so severe as on the heavier Crete and Fillmore soils, with their more compact and impervious subsoils.

The native vegetation on this soil consists chiefly of prairie grasses. On rolling areas subject to erosion, bluestem and Indian grass predominate, and on the smoother areas, buffalo and grama grasses are the most important. Areas too small for cultivation produce good growths of bunch grass for hay. From 5 to 7 acres are considered sufficient to support one horse or cow for a year, if the pasture is supplemented with feed during the winter months. The rougher areas are used entirely for grazing cattle.

Holdrege silt loam, rolling phase, is an important soil for the production of hay and for pasture. Probably less than one-fifth of its area in the county is under cultivation, the soil on the steeper and more gently rolling slopes being included in pasture or hay land. The wide distribution of this soil causes it to be included in most of the farms of the county bordering Republican River on the south or those along Little Blue River Valley. There is no natural timber on this soil, but there are small growths of early tree claims and shrubs, chiefly sumac, and along many of the narrow strips of included alluvial soil are scattered small cottonwood, ash, or elm trees.

Corn is the principal crop, and alfalfa, sorghum, and Sudan grass follow in importance. The minor crops planted are oats, rye, barley, and wheat. Owing to its unfavorable surface features and the lower organic-matter content of the topsoil, yields on this soil are slightly lower than on Hastings silt loam.

Owing to its loose, friable consistence and high lime content, this soil is exceptionally well adapted to the production of alfalfa, which is an excellent crop for the soil, as it prevents erosion, adds nitrogen, and increases the naturally low organic-matter content.

Small quantities of wheat and corn are sold for cash, but the greater part of the crops produced on this soil is fed to work animals, cattle, and hogs. Corn, alfalfa, native hay, sorghum, Sudan grass, and minor feed and hay crops, are fed to cattle, and alfalfa and corn constitute the principal hog ration. Some of the cattle are of the dairy types, and the cream sold is an important source of income.

Owing to its friable consistence and silty texture this soil, where favorably situated, is easily managed and may be cultivated under a wide range of moisture conditions. Although it has a tendency to clod when plowed wet, the lumps are easily broken. The greatest injury to which the soil is subject is washing on the steeper slopes, especially where it is planted to cultivated crops like corn. The furrows promote soil washing.

No commercial fertilizers are used on this soil. Barnyard manure is occasionally applied, but the supply is seldom sufficient for best results.

The current selling price of this soil ranges from \$40 to \$90 an acre, depending on the improvements, surface relief, and distance from market.

Other than increasing the organic-matter and nitrogen content by growing alfalfa, sweetclover, or other legumes, no treatment is more important in the improvement of this soil than measures taken to prevent erosion. Erosion can be retarded by placing brush, rubbish, and other waste materials in the incipient drainage ways. The labor involved will be small compared to the laborious efforts necessary to reclaim the land after it has been ruined by gullies.

WAUKESHA SILT LOAM

The topsoil of Waukesha silt loam continues to a depth varying from 20 to 24 inches. It is composed of three well-defined, dark-colored layers, a structureless mulch, a laminated layer, and a granular layer, all similar to those in the topsoil of the Hastings soils. The subsoil consists of two layers. The upper is the layer of maximum compaction, but the material is fairly friable and can be readily crushed between the fingers. This layer varies from 15 to 20 inches in thickness and consists of brown or grayish-brown, heavy silt loam or silty clay loam which has a tendency to break vertically into columns 5 or 6 inches in diameter. The columns are made up of smaller structural units, irregular or faintly prismatic in shape and from one-fourth to about one-half inch in diameter. The lower subsoil layer, below a depth of 40 to 50 inches is light yellowish-brown or in some places grayish-yellow, columnar, loose silt loam. It is slightly mottled with dark-colored inclusions and rust-brown stains, especially in old filled-in worm, root, or insect cavities. The material does not effervesce with dilute hydrochloric acid. At a depth of about 6 feet, it merges into the underlying loess from which it has weathered. The loess may or may not contain lime to a depth of 4 or 5 feet, but if lime is present it is uniformly distributed and there is no layer of unusual accumulation. The loess is columnar, grayish-yellow floury silt containing scattered rust-brown stains.

Waukesha silt loam includes numerous areas of too small extent to be shown on the soil map. In small scattered patches occurring either near the base of upland slopes or on narrow valley floors, the soil has developed no layers but consists solely of loose, friable, structureless silt loam continuing to a depth greater than 4 feet. The soil is very dark grayish brown or almost black to a depth ranging from 20 to 24 inches and is only slightly lighter in the lower part. Such soil is in reality Judson silt loam. Another variation common in Waukesha silt loam in Nuckolls County is the occurrence of a very dark grayish-brown finely granular layer in the lower part of the subsoil. This granular material is an old topsoil which has been covered by later deposits. Included also along the narrower drainage ways are numerous narrow strips of Wabash silt loam, light-subsoil phase.

Waukesha silt loam occupies low bench land and terrace positions along Republican and Little Blue Rivers and some of their larger tributaries, notably Elk Creek. The areas are irregular, most of them being long and narrow. This soil has developed from alluvial sediments which were deposited by streams when they were flowing at higher levels. Colluvial wash from the adjoining uplands, especially near the foot of the slopes, has also contributed material. Prolonged weathering and the accumulation of organic matter have changed the original deposits into the present soil.

The surface of Waukesha silt loam is flat or very gently rolling. As a rule the terraces lie well above overflow, but in the smaller valleys they are only a few feet above the flood plains. There is commonly a gentle slope downstream, and the soil is well drained, as the slope is sufficient in most places to carry off surplus water. Water may stand for a few hours in some of the flatter fields, but it soon percolates downward or evaporates.

This is the dominant terrace soil in Nuckolls County. Therefore it is agriculturally important. It is very strong and fertile and is well adapted to all crops common to the region. Originally it was covered with a thick growth of native prairie grasses, including buffalo grass, grama grass, bluestem, and Indian grass, but now more than 75 per cent of it is under cultivation, principally to corn. Wheat, oats, and alfalfa are of secondary importance.

Crop yields on this soil are slightly higher than on the upland soils, because Waukesha silt loam is more favorably situated with regard to the surplus run-off from adjoining higher levels and to depth to the underlying water table. Corn yields from 15 to 50 bushels to the acre, wheat from 15 to 40 bushels, oats from 20 to 40 bushels, and alfalfa from 2½ to 3 tons from three cuttings. In good years four cuttings of alfalfa are obtained, and the total yield for the season is correspondingly increased.

Most of the crops produced, with the exception of wheat, are used on the farms to feed work animals, hogs, dairy cows, and beef cattle. The surplus corn and oats are sold to local buyers. Most of the hogs are raised in the county, but the beef cattle are usually bought in outside markets and shipped in for fattening.

As a rule, no definite crop rotations are practiced and very little attention is given to fertilization, although recently most of the farmers are paying more attention to rotation of crops. The land is not in any immediate danger of exhaustion, as the surface wash from the adjoining uplands tends to maintain the fertility. However, crop rotations designed to maintain the proper chemical content and the application of barnyard manure, well spread and worked into the soil to maintain the organic-matter content, are necessary for the conservation of soil fertility.

HASTINGS SILT LOAM

The topsoil of Hastings silt loam in uncultivated areas consists of three layers. The upper layer is dark grayish-brown structureless silt loam, dustlike when dry, ranging from a mere film to 1 or 2 inches in thickness. It contains an abundance of more or less decomposed organic matter. The second layer is very dark grayish-brown or almost black friable silt loam composed of small, horizontal, platelike forms which overlap one another, giving the layer a laminated or platy appearance. The organic matter in this layer is even more abundant than in the surface layer, as is indicated by the slightly darker color. It is thoroughly mixed with the silt, and the material retains its color when it is pulverized. The third layer, which is more or less granular, is very dark grayish brown in the upper part and slightly lighter brown in the lower part. The material is similar in texture to that of the layer above, although it has a slightly higher clay content and, therefore, greater coherence. The soil particles are grouped into

rounded or semiangular aggregates varying from one-sixteenth to about one-fourth inch in diameter, the larger ones occurring in the lower part of the layer. The organic matter, although abundant, is not so thoroughly mixed with the mineral constituents as in the layer above but occurs chiefly as a film or coating on the surface of the granules. The film is thickest in the upper part of the layer and gradually becomes thinner with depth. This layer is about 15 inches thick and continues to an average depth of 24 inches.

Below the granular layer is the subsoil, which consists of two layers separated by transitional material. The upper is the layer of maximum compaction. It is from 10 to 14 inches thick, contains considerable clay, and is moderately compact heavy silt loam or silty clay loam. Numerous vertical seams and cracks are present, and the material breaks into columns from 4 to 6 inches in diameter. The columns are composed of more or less prismatic units, few of which exceed one-half inch in their longer or vertical dimension. This layer, which is grayish brown or light brown, is considerably lighter in color than the granular layer, owing to the continued thinning of the film of organic matter which covers the structure particles. Although it is much more compact than any other layer, this layer does not attain the density of a claypan and the material can easily be broken into its prismatic-shaped units or even pulverized between the fingers. When pulverized it is light grayish brown.

The transitional material of the subsoil is columnar but otherwise structureless silt or silty clay which overlies the layer of lime concentration. It is dark grayish brown and moderately compact in the upper part where it joins the layer of maximum compaction, but it becomes grayish-yellow floury silt in the lower part. The layer varies from 8 inches to 4 feet in thickness but commonly gives way to the lime layer about 6 feet beneath the surface.

The lime layer or the lower subsoil layer is light grayish-yellow or almost white, loose columnar silt containing an abundance of lime in several forms, such as concretions, spots, splotches, fine winding threads, and finely divided powderlike lime thoroughly mixed with the silt. The silt has no definite structure but breaks into irregular soft clods of various sizes. Beneath the lime layer is the unweathered or only slightly modified loessial formation from which Hastings silt loam has developed. The loess is commonly more or less calcareous but its lime content to the unit of volume is less than that of the lime layer.

The transition from the dark surface soil to the light-colored parent loess is very gradual. None of the layers is entirely uniform in color or texture. All variations, however, are slight and occur chiefly along old root, worm, or insect cavities which have become filled with material from above or below. The color and texture of the filling material depend on its source.

The profile described is typical of Hastings silt loam throughout the greater part of its occurrence in Nuckolls County. The soil, however, presents a few variations which are worthy of mention. The surface mulch in places contains an unusually large quantity of very fine sand, and small areas of Hastings very fine sandy loam are included in mapped areas of Hastings silt loam. In the more rolling areas the granular layer is in many places slightly thinner and the granules are smaller than in the more nearly level areas. Also this

layer generally is faintly columnar, a condition which is uncommon where the soil occupies nearly level surfaces.

The principal subsoil variations are in the density and structure of the layer of maximum compaction in the more rolling areas. In such places the subsoil is much more friable than typical, its density in places being only slightly greater than that of the overlying granular layer. Moreover, the prismatic structure is not so well defined as in the corresponding layer in smoother areas, and the material breaks naturally into larger lumps which, although more or less cubical, are apparently structureless.

The variations mentioned, particularly those pertaining to the granular layer and the layer of maximum compaction are numerous and occupy a rather large total area, but they occur in such small patches that it is impractical to show them on a small-scale map. Hastings silt loam and Holdrege silt loam resemble one another very closely. The Hastings soil differs from the Holdrege chiefly in the presence of a more pronounced granular layer and of a slightly denser layer of maximum compaction. Hastings silt loam is in reality transitional between the friable Holdrege soils and those which have developed a dense claypanlike layer in the upper part of the subsoils.

Hastings silt loam occurs on the narrower flat-topped divides which extend from the northern uplands toward the Republican River Valley. It also occurs extensively on the longer and more gradual slopes throughout those parts of the county where the loessial mantle has not been entirely removed by erosion. It is the principal soil on the large divides and interstream areas in the western part of the county.

Areas vary from nearly level to moderately rolling or sloping. Drainage is well developed. Surface drainage is somewhat excessive on the more steeply sloping areas where small patches of the soil are subject to considerable erosion. However, very little of the soil is badly gullied, and it retains moisture well.

Hastings silt loam is probably the best upland soil of the county for general-farming purposes. Its surface is not so level as that of Crete silt loam, but it has not developed the heavy claypanlike layer so characteristic of the Crete soils and therefore affords more available moisture and more favorable conditions for root development for the common crops, especially corn and alfalfa.

About 80 per cent of this soil is under cultivation, and the remainder, including the rougher areas, is used for pasture and hay land. The native vegetation consists of a large variety of nutritious grasses, chief among which are bluestem, grama grass, buffalo grass, and wheatgrass. These grasses afford excellent pasture and when cut for hay yield one-half or three-fourths ton to the acre, depending on the season.

Corn, wheat, alfalfa, and oats are the leading cultivated crops, ranking in acreage in the order named. Corn yields from 20 to 50 bushels to the acre, averaging about 30 bushels. Most of the corn is either fed to livestock on the farms where it is produced or is sold to local buyers for fattening cattle. Wheat yields from 15 to 30 bushels to the acre. It is the chief cash crop, and most of it is sold in local elevators soon after harvesting. The average yield of alfalfa is about 2½ tons to the acre from three cuttings. Alfalfa is the chief hay crop and is nearly all fed to livestock. Oats yield from 20 to 40

bushels to the acre. This grain is grown chiefly to feed the work animals, and very little of it is sold.

Small patches of Sudan grass, sorghum, millet, and rye, and enough garden vegetables to supply home needs are grown on most farms.

The raising of beef cattle, chiefly Herefords, is an important industry on uncultivated areas of this soil, and cattle fattening is becoming a specialized industry on many farms. Most of the cattle to be fattened for market are raised in the county, although many farmers ship in a carload or two of beef cattle annually, feed the animals corn and alfalfa for a period of 60 or 90 days, and return them to Kansas City or Chicago markets. Hogs are raised on nearly every farm.

Crop rotations are not systematically followed on Hastings silt loam, although most farmers change their crops every few years and grow more or less alfalfa, which tends to maintain the fertility of the land. Available barnyard manure is applied. Hastings silt loam sells at prices ranging from \$75 to \$150 an acre, depending on location, improvements, and surface relief. The higher price is obtained for level land near towns.

HALL SILT LOAM

The surface layer of Hall silt loam consists of a dark grayish-brown, structureless silt loam mulch 1 or 2 inches thick. The material is loose but is thickly matted with grass roots. Where the soil is associated with soils of sandy texture, the mulch is very fine sandy loam in some places. A large quantity of organic matter, in several stages of decomposition, is present. The second layer is laminated and is from 2 to 6 inches thick. It is very dark grayish-brown or almost black friable silt loam and is composed of small, fragile, platelike disks which are so interlocked with one another as to cause the characteristic laminated or platy appearance of the layer. When handled the material breaks into very fine granules to which the smaller grass roots cling tenaciously. These granular particles are angular and more or less rounded and vary from one thirty-second to about one-sixteenth inch in diameter. This layer is uniform in color, as the organic matter is abundant and thoroughly mixed with the soil mass. In many places it contains cysts or pockets of worm casts, some of which are well preserved. The third, or granular layer of the topsoil is characterized by its finely granular structure and, in places, by its large number of worm casts. It consists of very dark grayish-brown, finely granular heavy silt loam which is slightly tighter than the overlying laminated layer, owing to its higher clay content. It is only faintly compact and can easily be crushed between the fingers. The resultant powder is only slightly lighter in color than a broken surface. Although this layer contains a few spots and splotches of slightly lighter or darker brown, it is fairly uniform in color. The color variations usually follow groups or chains of granules but comprise a very small proportion of the total volume. Small, well-rounded worm casts are common. Few of the oval pockets in which they occur exceed one-half inch in diameter.

The next lower layer consists of transitional material which grades into the layer of maximum compaction. This transition layer is commonly not more than 6 inches thick. It is very dark grayish-brown silty clay loam, is slightly more compact than the overlying layer, and contains numerous small spots and splotches of slightly

lighter brown material. This layer contains a few worm casts, most of which have been modified so that they are no longer spherical. The material of this layer can be broken with little difficulty into a loose granular mass, the decidedly angular granules varying from one-sixteenth to one-fourth inch in diameter.

The upper subsoil layer or layer of maximum compaction consists of dark grayish-brown, moderately compact silty clay loam, which is in most places not more than 12 inches thick and which is only slightly lighter in color than the overlying transition layer. It is characterized, however, by its greater compaction, higher clay content, and more pronounced columnar form. The material is mottled and splotted with lighter brown spots. It breaks into coarse lumps or irregular aggregates ranging from one-fourth to one-half inch in diameter. This material is readily crushed between the fingers and when pulverized is light grayish brown. Only a few worm casts are present, but borings or round linear inclusions about one-fourth inch in diameter and varying in color from dark grayish-brown to gray are common. The inclusions probably represent worm or insect cavities, some of which have been filled by darker material from the layers above and some by lighter material from the underlying layers.

In some places a transitional layer occurs between the layer of maximum compaction and that of lime accumulation. This transitional material is light grayish-brown heavy silt or silt loam. It has a faint columnar form but no structure, breaking into rather soft, irregular clods. It is friable but is a trifle more resistant than the average loessial material. When powdered, it is only slightly lighter than a broken surface. It contains a few wormholes, root channels, borings, and casts in cysts. The material of the borings is darker and decidedly more compact than the surrounding material.

Beneath this layer is the layer of highest lime concentration. In most places, this layer begins at a depth of 3 or more feet and it has been found to continue below a depth of 8 feet. It consists of very light grayish-brown, loose, structureless silt or silt loam, the upper part of which is slightly more compact than the lower, although it crushes readily into fine powder. Lime is abundant, both in powdered form and as soft and hard concretions, the proportion of each varying widely with local conditions. Here and there animal burrows, filled with very dark grayish-brown or almost black granular silt loam, extend into this layer. In exposed cuts and excavations the structure is pronouncedly columnar, the columns being about 5 inches in diameter.

The principal variations from the typical profile just described are in the number and thickness of the layers, the density of the layer of maximum compaction, and the lime content of the lime layer. However, Hall silt loam is fairly uniform throughout Nuckolls County. The chief variation in the surface soil is in the texture, but the areas of different texture were too small to differentiate on the map. The most important variation in the subsoil occurs on the higher terraces, such as those near Bostwick and east of Superior, where the layer of maximum compaction has claypan characteristics and closely resembles the corresponding layer in Crete silt loam. Elsewhere, especially on the low terraces, this layer is friable and similar to the corresponding layer in Holdrege silt loam. The material is readily crushed

between the fingers. A large percentage of the Hall silt loam, as mapped in this county, includes a variation which might be called the high-terrace phase. The soil is identical with the typical soil in all its significant features. It occupies very high old terraces whose surfaces lie about 100 feet above the present stream channels. These included areas occur only in the Republican River Valley, and few of them extend far along the tributary drainage ways. The principal area of this kind is on the north side of the river where the soil forms a moderately wide belt.

Hall silt loam occurs in irregular areas on both the high and low terraces of Republican River. One area lies along Elk Creek. The soil is derived chiefly from valley loessial materials deposited as flood-plain sediments at a time when the streams were flowing at higher levels. In a few areas the soil is derived from colluvial wash and materials brought in from near-by upland areas.

Areas of this soil are nearly flat, with a gentle slope downstream. Drainage is good but is nowhere excessive. This soil is not subject to overflow from the main streams, but in a few places it receives discharge from small streams emerging from the uplands.

This is one of the most fertile soils in the county. Owing to its high organic-matter content, smooth surface, and favorable structure and texture, it is important agriculturally. It is naturally strong and will endure severe cropping for several years, even under poor management. Practically all of it is under cultivation. The original native vegetation included the same species of grasses as occur on the uplands.

The principal crops are corn, wheat, oats, and alfalfa. Crop yields compare favorably with those obtained on the Hastings and Holdrege soils and in some places are slightly higher, especially in those areas which are favorably situated to accumulate the surface run-off from higher lands. Corn yields from 20 to 50 bushels, wheat from 10 to 30 bushels, oats from 25 to 40 bushels, and alfalfa from 1 to 3 tons to the acre. Alfalfa is cut three times during the season. Yields depend on the amount and distribution of the rainfall. Corn is the leading crop.

The farming system employed is ordinarily one of combined grain farming and livestock production. Most of the crops produced, with the exception of wheat, are used on the farm to feed the work animals, hogs, dairy cows, and beef cattle. On some farms there is a surplus of corn and oats, which is sold to local buyers. Most of the hogs are raised in the county, but the beef cattle are usually shipped in to be fattened. The cultivation methods are similar to those practiced on the level upland soils. The soil is easily managed and is comparatively exempt from excessive denudation and leaching. No commercial fertilizers are used, as the soil is in no immediate danger of exhaustion. Barnyard manure is locally applied, and through its use the organic-matter content of the soil and its good tilth are largely maintained.

As a rule, no definite rotations are practiced. However, many farmers are giving more attention to crop rotations, and the tendency to change crops with some regularity is increasing.

The selling price of Hall silt loam ranges from \$75 to \$100 an acre, depending on improvements and proximity to markets.

JUDSON SILT LOAM

Judson silt loam is a comparatively recently deposited soil in which weathering has not developed the succession of layers characteristic of the older upland and terrace soils. The topsoil, which continues to an average depth of 20 inches, is very dark grayish-brown or almost black friable silt loam, rich in organic matter. The material has a faintly granular structure and is composed of a rather loose mass of semirounded soil particles from one-sixteenth to one-eighth inch in diameter. The particles, however, are more or less vaguely outlined and blend to such a degree that the material has a massive or structureless appearance.

The subsoil continues below a depth of 5 feet. It is slightly lighter in color than the topsoil but in all other respects is similar.

This soil breaks into more or less columnar forms 4 or 5 inches in diameter. These columns have horizontal seams and cracks at irregular intervals and can be broken into more or less prismatic lumps from 6 to 10 inches long. The lumps have no definite lines of cleavage. Neither the topsoil nor the subsoil contains sufficient lime to react with hydrochloric acid.

Judson silt loam is fairly uniform throughout Nuckolls County. In a few small included areas the subsoil, below a depth of 3 feet, consists of light-gray limy silt. In a few places the subsoil contains darker-colored layers or streaks. Most of these dark-colored layers lie below a depth of 6 feet, but in some places they may be within 40 inches of the surface. These inclusions are old weathered surface soils which have been buried by more recent deposits. Judson silt loam is very closely associated with Waukesha silt loam, into which it grades almost imperceptibly, and in many places the boundary lines between the two soils are arbitrary. In a few places the areas of Waukesha silt loam and Judson silt loam are so small and so mixed that they were mapped with the dominant soil.

Judson silt loam is widely distributed throughout the county. It was developed largely either from colluvial deposits of silt brought down from the higher silty upland soils or by the weathering of silt and very fine sand carried in by the streams when they flowed at higher levels. It is of comparatively recent origin, and sufficient time has not elapsed to develop the distinctly lighter colored subsoil characteristic in the older terrace soils. This soil occupies the foot of the slopes between the terraces and uplands, the slopes between the uplands and the first bottoms, and terraces along Republican River, Little Blue River, Elk Creek, Liberty Creek, and their tributaries. Although areas are not subject to overflow, the soil is continuously subject to modification by colluvial and alluvial action, particularly where it occurs at the point of emergence of small tributaries carrying sediment.

Areas of this soil are almost flat, with a slight slope in the direction of the adjacent stream. The land is cut here and there by the drainage channels of watercourses flowing from the uplands into the larger valleys, but it is not subject to rapid erosion.

Drainage is good. Ordinarily the open-structured though not porous subsoil allows the ready absorption and movement of surplus moisture. The location of many areas of this soil near the mouths of small drainage ways, which discharge on its surface, is favorable to crops in periods of prolonged drought.

Owing to its high organic-matter content, good moisture conditions, and favorable structure and texture, this soil is important agriculturally, and with good farming methods is easily kept productive. About 75 per cent of it is under cultivation. The high organic-matter content and the friable consistence of the soil tend to make it drought resistant. It is considered a very valuable farming soil, equal to Waukesha silt loam in productiveness.

The principal crops grown on this soil are corn, oats, and alfalfa. The native vegetation on untilled areas is a dense growth of prairie grasses. Corn occupies the largest acreage and yields from 20 to 50 bushels to the acre, depending on the rainfall. Oats yield from 20 to 40 bushels and alfalfa from 2 to 3 tons to the acre. The minor crops are rye, barley, sorghum, and Sudan grass. Wheat is a cash crop, but its acreage on this soil is seldom large. Yields of wheat vary from 10 to about 35 bushels to the acre.

Judson silt loam is important in the livestock industry of the county. Most of the crops produced are fed to animals on the farm. Corn is the principal feed of the larger animals, supplemented by alfalfa, tame hay, wild hay, and forage crops. Practically every farmer has one or more cows, and surplus cream or other dairy products are sold. Alfalfa is also an important hog feed.

Cultural methods are similar to those used on Waukesha silt loam. The soil is easy to manage. No commercial fertilizer is applied, but barnyard manure, distributed by a spreader, is used by many farmers.

Judson silt loam has an average selling price between \$100 and \$125 an acre. A higher price is obtained for well-improved farmsteads near towns.

Like Waukesha silt loam, Judson silt loam is one of the best terrace soils in the county. Under the prevailing rainfall, it is superior to Waukesha silt loam as its organic-matter content is commonly larger and the organic matter continues to a greater depth. Its open friable consistence facilitates the absorption of rainfall, checks evaporation, prevents cracking, and renders the soil very drought resistant. Its fertility is in no immediate danger of exhaustion, but the importance of this soil demands conservation methods designed to maintain its permanent productiveness. Such methods include a system of crop rotation by which the elements needed for any particular crop are allowed to accumulate in sufficient quantity by alternation with crops using other plant foods or by the economical application of barnyard manure, much of which is now wasted.

JUDSON VERY FINE SANDY LOAM

Judson very fine sandy loam is similar in all its characteristics to Judson silt loam, except that it contains slightly more very fine sand and is therefore a little more friable and mellow. It is very poor in lime, except locally where a few lime fragments from higher areas have become mixed with the soil mass.

Judson very fine sandy loam occurs only in a few small areas and narrow strips in the Republican River Valley, where most of it lies near the boundary of the terraces and bottom lands. The surface is nearly level but has a gentle slope down the valleys and a noticeable dip toward the streams.

This soil has been derived from dark-colored deposits carried to their present position partly as colluvial material from the adjoining terraces or uplands and partly as alluvial sediments from farther upstream. Drainage is thorough though not excessive and none of the land is subject to active erosion.

Owing to its small extent and patchy occurrence Judson very fine sandy loam is of little agricultural importance in Nuckolls County. It is very strong and fertile, however, and in counties where it occurs more extensively is a very valuable general-farming soil. It is adapted to all crops common to the region, especially to corn and alfalfa. Crop yields equal or slightly exceed those obtained on Waukesha silt loam.

WABASH SILT LOAM, LIGHT-SUBSOIL PHASE

The surface layer of Wabash silt loam, light-subsoil phase, is dark-brown or very dark grayish-brown smooth structureless silt loam 4 or 5 inches thick. The subsurface layer, which continues to a depth of 12 or 15 inches, is dark grayish-brown faintly granular, slightly compact but rather friable silt loam. The subsoil, which continues to a depth of 4 or 5 feet without change, is dark-brown very friable silt loam, also faintly granular. The surface soil is rich in organic matter, and the surface layer in uncultivated areas is thickly matted with grass roots. The organic-matter content gradually decreases with depth, although the dark color of the subsoil indicates that there is no deficiency of this material. In a few places small iron concretions and faint-brown or rust-brown iron stains are present in the lower part of the soil. Neither topsoil nor subsoil is limy.

This soil differs from typical Wabash silt loam, as mapped in other counties of Nebraska, in the structure of the subsoil. The typical areas have dark-drab or gray, heavy compact subsoils, tinged with blue in many places, but in Nuckolls County there is no pronounced difference in texture or color between topsoil and subsoil, and the material somewhat resembles Judson silt loam except that it occurs on flood plains and very low bench-land situations where it is subject to occasional overflow.

This soil presents some variations from typical. Small areas of silty clay loam and loam are included in mapping. In places, the subsoil is heavy, brownish-gray silty clay loam, similar to typical Wabash silt loam. Locally, small lime concretions and fragments are scattered through the subsoil. These are derived in part from the larger concretions of the upland loess and in part from the Niobrara chalk. The materials were carried to their present position by colluvial or alluvial action. The lime particles are largely unaltered since deposition. Also included with Wabash silt loam, light-subsoil phase, especially in the southwestern hilly uplands, are narrow strips within the flood plains of the larger ravines in which the soils are lighter in color than typical and in which both topsoil and subsoil are limy. The lime, which occurs chiefly in the form of small irregular fragments, is derived largely from the near-by Niobrara chalk.

Wabash silt loam, light-subsoil phase, has a wide distribution in Nuckolls County. It occurs as narrow linear strips from a few rods to about a quarter of a mile in width on the flood plains and lower

terraces of most of the large drainage ways. Because of their size, many of the narrower strips are not shown on the soil map, but the soil occupies at least part of the flood plains along nearly every drainage way in the county. In the smaller valleys the narrow bands are continuous, but in the larger valleys the areas are detached. The soil is derived from reworked silt and clay deposits laid down in flood-plain situations during periods of high water.

The surface of this soil is almost level. It is varied only by the stream channels of the major valleys and their tributaries. Drainage is good. The structure of the topsoil and subsoil favors the movement of internal moisture, and the surface has a slight slope down the valley toward the streams. Much of this soil is not subject to overflow except in unusual freshets, and none of the areas show the poorly drained subsoil conditions of the typical Wabash soils.

On account of its occurrence in such narrow strips, this soil is of little agricultural importance in Nuckolls County. However, it is very strong and fertile and is well adapted to all crops commonly grown. About 40 per cent of it is under cultivation, and the remainder is included in pasture and hay land. The native vegetation consists of grama grass, buffalo grass, bluestem, and Indian grass. Corn and alfalfa are the principal cultivated crops. Corn yields from 25 to 50 bushels and alfalfa from 2½ to 3 tons to the acre. Alfalfa is usually cut three times during a season. Small grains are not grown extensively, as they have a tendency to grow rank and lodge, especially in wet years.

Beef and dairy cattle are grazed on areas not under cultivation. Most of the land borders drainage ways which carry water at least a part of the year. In many places areas of rougher upland soils comprise the greater part of the pastures. This is an excellent hay-producing soil. The native grasses yield from one-half to three-fourths ton of hay to the acre.

No definite crop rotation is followed, nor is a rotation necessary at the present time as the fertility of the soil is largely maintained by the addition of material washed from the higher slopes. The level surface, silty texture, and friable consistence make this soil very desirable for general farming.

The current sale price of Wabash silt loam, light-subsoil phase, ranges from \$90 to about \$150 an acre, depending on location, drainage, and improvements.

Wabash silt loam, light-subsoil phase, is one of the most valuable soils in the county. Narrow strips are included in nearly every farm, and because of the presence of water and good pasture in addition to the excellence of the soil for cultivated crops, it is an all-round soil.

WABASH SILTY CLAY LOAM

The topsoil of Wabash silty clay loam is very dark grayish-brown or nearly black heavy silty clay loam, 8 or 10 inches thick. It is sticky and plastic when wet but becomes hard and compact on drying. The upper part of the subsoil is black or dark-drab compact silty clay or clay loam, which may locally contain thin layers of lighter textured and lighter colored material. The lower part of the subsoil is gray with a bluish tinge, is compact, and is faintly mottled with rust-colored iron spots. The material is dense, is comparatively

impervious, and may locally contain scattered lime concretions in the lower part although typically it is very poor in lime. Both topsoil and subsoil are rich in organic matter. In the typical soil the tough subsoil continues below a depth of 40 inches, but in some places it includes light sand layers, most of them not more than a few inches thick. Mapped areas of this soil include small areas of Wabash silt loam.

This soil occurs in only one area in section 32, T. 1 N., R. 6 W., on the flood plains of Republican River. The surface is level or gently sloping, and the gradient is so slight that natural drainage is inadequate except in dry years. The heavy, dense subsoil does not favor internal drainage.

Owing to its small extent, this soil is of only local agricultural importance. Most of it is used for pasture. The native vegetation consists largely of bluestem, slough grasses, and salt grasses. Where properly drained, the soil is suited to the production of corn and wheat, but under present conditions it is too moist for grain production.

Drainage by open ditches or tile is necessary before this soil can be profitably utilized for crops. When used for pasture, about 4 or 5 acres are allowed for each animal.

CASS SILT LOAM

The surface layer of Cass silt loam is friable, granular dark-brown or very dark grayish-brown silt loam 8 or 10 inches thick. It contains a large quantity of organic matter and in places a very high percentage of very fine sand. The next lower layer, which continues to a depth ranging from 14 to 18 inches, is friable silt loam or fine sandy loam. It is dark grayish brown and is distinctly lighter in color than the layer above. The subsoil is variable. Typically it is yellowish-gray sand which continues to a depth of 4 feet or more below the surface. The lower part of the subsoil is in many places gray very fine sand with a brownish cast caused by the iron mottles present. Elsewhere the mottles are bluish gray and dark gray. The subsoil is loose and friable but is sufficiently coherent to stand alone in river banks cut at fairly steep angles. In Nuckolls County it has a high lime content.

Owing to the topographic position and recent formation of this soil, areas of Cass silt loam vary greatly within short distances. In many places, at a depth ranging from 24 to 40 inches, the subsoil layer is silty very fine sandy loam which is slightly darker than the typical subsoil. Owing to a higher silt content, it is also more compact. This layer extends as an irregular more or less wavy band along the face of cut banks, giving the impression that once it was an uneven surface deposit. Elsewhere the sand underlying Cass silt loam is almost pure white, in most places is of very fine sandy loam texture, and consists largely of quartz. In a few places, however, the texture may be coarser and the subsoil may be composed largely of coarse sand or very coarse sand. The surface soil also is variable. Within a few feet it may be silt loam, heavy loam, silty clay loam, or very fine sandy loam, but the dominant texture in all areas sufficiently large to map is silt loam.

Cass silt loam occurs extensively along the first bottoms of Republican and Little Blue Rivers. Most of it along Little Blue River is

adjacent to the river channel, but most of the areas in the Republican River Valley lie at some distance from the river. This is one of the more extensive flood-plain soils of the county.

Areas of this soil are flat, except in a few places where they are modified by narrow elongated depressions representing old cut-off channels or tributary valleys, most of which are now sloughs, swales, and wet marshy areas. Most of the land is subject to overflow in years of excessive rainfall. Normally, however, drainage is adequate for successful crop production. The loose, porous subsoil affords internal movement of water, and the surface is sufficiently sloping to prevent any except local accumulation of water.

Cass silt loam is one of the more important flood-plain soils in Nuckolls County. Less than one-half of it is under cultivation, however, as it is subject to overflow. The native vegetation consists of both tree growth and tall moisture-loving grasses. The grasses include bluestem, Indian grass, and some marsh grasses. The tree growth consists of peach-leaved willow, which is especially abundant along Little Blue River, of cottonwood, which grows to a fairly large size, and of elm, which attains a moderate size. A few blackberry briars are found, and there are some boxelder and ash trees but these trees do not stand the moist bottom-land conditions so well as do the cottonwoods and willows.

The uncultivated areas are not highly favored for pasture land, as many of them are exceedingly weedy, owing largely to overgrazing and the frequency of overflows. Sunflowers grow very tall, and there is a tangle of smartweed, lamb's quarters, morning-glory, nettles, sand burs, and pigweed. The soil, however, is naturally strong and fertile and where adequately drained is well adapted to all crops common to the region. Corn, oats, barley, and alfalfa are the leading crops. They do well and give good yields in all but the driest or wettest seasons. Corn yields from 25 to 50 bushels, oats from 30 to 40 bushels, and alfalfa from 2 to 4 tons to the acre. Alfalfa is usually cut three times and does exceptionally well, owing to the high lime content of the subsoil and the ease in reaching ground water. As on all heavy bottom-land soils, oats ordinarily grow very rank, and the short-straw varieties must be planted to give the best returns. Wheat is seldom grown.

Most of the corn is fed to hogs on the farms where it is produced. Alfalfa and oats are fed to work animals and dairy animals. Other crops are used for feeding purposes or are sold to local farmers.

Cass silt loam is easily managed and can be cultivated without injury under a fairly wide range of moisture conditions. Owing to the friable consistence of the surface layer this soil is considered slightly superior to Cass silty clay loam. Crops seldom suffer except during the most prolonged droughts.

Much of the sand and gravel underlying this soil is used for building purposes, road improvement, and general construction work.

Definite crop rotations are not followed by most farmers, but crops are changed irregularly every few years. Alfalfa is planted extensively, and this crop tends to interfere with short rotations.

No commercial fertilizers are used, but barnyard manure is applied in spring and fall. The physical qualities and flat, even surface, together with the high natural productiveness, make this an excellent general farming soil.

The current selling price of Cass silt loam ranges from \$75 to \$100 an acre.

CASS VERY FINE SANDY LOAM

The surface layer of Cass very fine sandy loam is dark grayish-brown, loose mellow very fine sand, 3 or 4 inches thick, which contains an abundance of organic matter and considerable silt. It is underlain by grayish-brown fine or medium sand, a foot or more thick, containing much less organic matter than the surface layer. Below a depth varying from 15 to 18 inches the material grades into loose, incoherent fine or medium gray sand which contains practically no organic matter but does contain considerable lime. This coarse-textured material continues to a depth of several feet.

Although the soil as described is typical of Cass very fine sandy loam in Nuckolls County, many variations were noted. The only constant characteristics of this soil are its dark-colored topsoil and light-colored sandy or gravelly subsoil. Within short distances, the texture of the surface material may vary from silt loam to fine sandy loam or even to loamy sand, but practically all areas sufficiently large to map are dominantly very fine sandy loam in their surface layers. The subsoil also may vary greatly. In some places it consists of alternating layers of coarse and fine sand. Elsewhere it contains thin layers of very dark-colored silt loam which may occur at various depths and which probably represent old surface soils buried by more recent deposits.

This soil is rather extensive in Nuckolls County. It occurs in the bottom lands of Republican and Little Blue Rivers. The largest areas are in Republican River Valley.

The surface of the land is prevailingly flat, but it is locally modified by old cut-offs, stream channels, and narrow, linear, shallow depressions. Much of the soil is subject to occasional overflow, but the porosity of the sands affords good internal drainage and during most years crops do not suffer from excess moisture. The nearness of the underlying water table prevents severe droughts even in the driest years.

Cass very fine sandy loam is of very great agricultural importance in both Republican and Little Blue River Valleys. Its structure renders it easy to cultivate, and it can be handled under the widest range of moisture conditions. It has enough body to rank as a fairly strong soil. About 60 per cent of it is under cultivation, and the remainder is devoted to grazing. The areas in Little Blue River Valley are subject to frequent overflow and are generally used for grazing purposes, whereas those in the Republican River Valley, which are less subject to overflow, are used for cultivated crops.

The uncultivated areas are well covered with grasses. Where the land has not been subjected to excessive grazing or too frequent overflows it affords excellent pasture. The more common grasses include bluestem, stipa or needle grass, and sand grasses. Adjacent to the river channels are strips of cottonwood and willow trees, together with scattered elm, boxelder, and ash. A dense undergrowth of weeds, vines, and brush, which becomes exceedingly rank in years of abnormal stream overflow, abounds. These plants encroach on the cultivated areas in many places.

Corn and alfalfa are the principal crops. Corn produces from 30 to 50 bushels to the acre and alfalfa from 3 to 4 tons of hay from

three cuttings. Small grain is not commonly grown on this soil on account of the difficulty of obtaining a firm, compact seed bed. The soil is valued, however, for forage crops, and small acreages of sorghum, kafir, Sudan grass, and clover are planted for this purpose by many farmers. Potatoes, garden vegetables, and melons do well, as the soil warms up early in the spring and contains sufficient moisture to give good yields of truck crops.

The largest part of the crops produced on this soil is fed to live-stock. Some farmers, however, sell a large part of their corn crop to local cattle feeders.

Owing to its sandy texture, this soil can be worked in the spring before the other bottom-land soils and it is among the first to become sufficiently warm for seed germination. No commercial fertilizers are used and the supply of barnyard manure is generally inadequate. The soil is not so strong as the Waukesha and Wabash soils, and crop yields, especially where crops are not rotated, decrease from year to year.

The current selling price of Cass very fine sandy loam ranges from \$50 to \$125 an acre, depending on location and drainage conditions.

CASS SILTY CLAY LOAM

The topsoil of Cass silty clay loam is composed of two fairly well defined layers. The upper layer is 1 or 2 inches thick and consists of very dark grayish-brown or almost black heavy, silty clay loam. It is rather compact and extremely plastic when wet but has a finely granular structure and when dry can be broken into small angular units about one-eighth inch in diameter. The second layer of the topsoil continues to a depth of about 15 inches. It has about the same texture and density as the overlying layer but is slightly lighter in color, being grayish brown or dark grayish brown. The material is more or less mottled with gray and rust-brown seams, splotches, and specks. The subsoil is yellowish-gray or light-gray, fine, coarse, or medium sand, containing a small admixture of silt and clay, in most places sufficient to give it some consistence. The layer continues to a depth of 50 or more inches. In some places one or more thin layers of heavier textured materials, commonly silt loam or silty clay, are present.

The topsoil receives its dark color from the abundant organic matter derived from the decaying vegetation. The lower subsoil layer is practically devoid of organic material. Unlike Cass silt loam, where the subsoil consists of comparatively finer textured sands and hence is more poorly drained internally, Cass silty clay loam is comparatively free of iron stains, though these occur in some places and iron concretions are found here and there in the subsoil. Although the areas of Cass silty clay loam are more or less uniform, the surface texture varies within very short distances and may be silt loam, loam, or very fine sandy loam, depending on the velocity of the overflow waters which caused the backwater conditions under which Cass silty clay loam was accumulated.

This soil occurs only on the flood plains of Republican River, in elongated, irregular areas lying some distance from the present channel of the river. The surface is flat or basinlike, as most of the soil occupies low positions where there is little surface outlet. Owing to

the very heavy texture of the surface soil water gathers in pools and remains until it evaporates. Consequently surface drainage is inadequate. The sandy subsoil, however, insures fair internal drainage, so that where adequate surface drainage is provided the soil is seldom water-logged and is admirably suited to the production of crops.

Cass silty clay loam is not important agriculturally. The total area is not large, and only a small acreage is under cultivation. Most of the soil is used for hay and pasture land. The most common native grass is the tough salt grass, and small patches of buffalo grass, grama grass, bluestem, and Indian grass grow on the better drained and lighter textured areas. An average of about 1 ton of hay to the acre is obtained, and 2 or 3 acres of pasture land are necessary for feeding one animal during the grazing season.

This soil is strong and well adapted to all crops commonly grown in the region. Corn and alfalfa are the principal crops. Corn yields from 20 to 40 bushels and alfalfa from 3 to 5 tons to the acre from three cuttings. As the soil is commonly included in farms where livestock feeding is an important industry, most of the corn and alfalfa produced is fed to cattle and hogs.

This soil is rather difficult to manage on account of its high clay content, but it can be worked under most moisture conditions except excessive wetness or dryness. If plowed when wet, clods which are not easily broken down in later cultivation are formed. The texture of the surface layers prevents rapid absorption of moisture and, unless artificially drained, the fields tend to puddle following heavy rains.

No definite rotation is practiced, although crops are changed irregularly every few years. Alfalfa is one of the most successful crops on the soil after a good stand has been obtained, as the water table is within easy reach of the long root system.

No commercial fertilizers are used, but a small quantity of barnyard manure is occasionally applied.

CASS SANDY LOAM

The topsoil of Cass sandy loam, to a depth of about 8 inches, consists of dark grayish-brown loose, open sandy loam. The upper part of the subsoil is dark olive-drab sandy loam, very loose and incoherent. The lower part of the subsoil, below a depth of about 30 or 35 inches, is olive-gray sand, very loose and incoherent. Both topsoil and subsoil are poor in organic matter, but the topsoil is not so poor in this material as is the corresponding layer in Sarpy loamy sand and is consequently much darker. In most places lime is not present above the upper subsoil layer, but the lower subsoil layer contains small lime concretions and inclusions and is also streaked with rust-colored iron stains. In places the entire subsoil contains considerable coarse sand and grades into fine gravel at a depth of about 3 feet. The substratum is commonly clean quartz sand or gravel containing little organic matter. In places the subsoil is streaked and banded with layers of dark-colored silt loam, fine sandy loam, or very fine sandy loam. These bands vary from 1 to more than 4 inches in thickness. The dark layers represent old surface soils in which considerable organic matter had accumulated prior to the deposition of the more recent alluvial sediments.

This soil occurs in only a few very small areas in the flood plains of Republican and Little Blue Rivers and along several tributaries of Republican River northwest of Bostwick. It is closely associated with soils of the Sarpy series and other members of the Cass series. The surface is flat or gently undulating. In a few areas, where the wind has whipped the loose incoherent sand into low, rounded ridges, the relief is rather hummocky. Owing to the sandy texture drainage is excellent.

This soil is unimportant agriculturally. About 20 per cent of it is under cultivation. The native vegetation consists chiefly of sand grasses and bluestem. Corn is the principal cultivated crop, and yields range from 20 to 25 bushels to the acre.

This soil is easily managed but is subject to blowing in dry seasons and to overflow in periods of excessive rainfall. The water table, however, lies near the surface and thus affords favorable moisture conditions for crops during seasons of normal or low rainfall. As the soil is deficient in organic matter, the planting and plowing under of green-manure crops or the application of large quantities of waste plant material is advisable. Most of the soil is better suited to use as pasture land or for hay production than for cultivated crops.

NUCKOLLS SILT LOAM

Typically, the surface layer of Nuckolls silt loam is very dark grayish-brown silt loam or very fine sandy loam, which varies from a mere film to about 1 inch in thickness and which forms a loose, mulchlike covering similar to that on the Holdrege and Hastings soils. The second layer differs from the immediate surface layer in structure. It is commonly about 4 or 6 inches thick and is similar to or slightly darker than the dust mulch, but it has a faintly laminated or platy structure. The plates or laminae break into fine rounded granules averaging about one sixteenth inch in diameter. The material of this layer is composed of loose, mellow loam containing considerable very fine sand, some fine sand, and a rather high percentage of organic matter, which is thoroughly mixed with the mineral particles of the soil. A few scattered filled-in insect or worm cavities occur here and there throughout this layer. The laminated layer is underlain by an 8 or 10 inch layer of similar material, which differs in that it is decidedly granular in structure and is slightly lighter in color. The small soil particles are grouped into rounded or semiangular granules from one-eighth to one-fourth inch in diameter. The organic matter occurs chiefly as a film or coating on the surface of the granules. The film is thickest in the upper part of the layer, therefore that part of the soil is as dark as the laminated layer. The film decreases in thickness with depth and near the bottom of the granular layer the color is dark grayish brown. As the organic matter which gives the layer its dark color occurs largely on the surface of the granules, the granules when crushed are slightly lighter in color than they are when unbroken and are decidedly lighter than crushed material from the laminated layer, indicating that the granular layer contains less organic matter to the unit of soil volume than the layer above it.

The subsoil consists of two layers. The upper subsoil layer, although only moderately compact, is the densest layer throughout the soil. It is light reddish-brown heavy silt loam which continues

to an average depth of 36 inches. The material is coarser in structure than that of the granular layer and is composed of small, irregular, angular lumps ranging from one-fourth to one-half inch in diameter. The layer is reddish brown somewhat mottled with very dark grayish brown along old filled-in insect, root, or worm cavities. The organic-matter content is lower than in the granular layer. The slight compactness of the layer is evidently owing to a somewhat higher clay content than occurs in any other layer. The lower part of the subsoil is characterized by a faintly developed columnar breakage and a high content of lime. It is the layer of maximum lime accumulation and consists of friable, structureless silt, with a light reddish-brown basic color. It contains much white lime in the form of soft and hard concretions and filmlike splotches and streaks. Filled-in insect borings are few and their color is commonly slightly darker than that of the soil mass.

The lower subsoil layer of Nuckolls silt loam at an average depth between 4 and 5 feet merges with the parent material of structureless, pale reddish-brown columnar silt known in the Nebraska surveys as the Loveland phase of the loess. The lime present is fairly uniformly distributed and the quantity to the unit of volume is less than in the layer of lime accumulation.

Numerous variations from typical are included in mapped areas of Nuckolls silt loam. The thickness and color of the topsoil vary with the relief and severity of erosion. On the gentler slopes the topsoil is very dark and rather deep. In pockets or basinlike places where material from the surrounding higher areas has washed or slumped on the surface, it may attain a thickness of $2\frac{1}{2}$ or 3 feet. On the steeper hillsides, on hill shoulders, and on small ridges, erosion is severe and the surface soil has either been greatly thinned or entirely removed, exposing the characteristic reddish-brown upper subsoil layer. On the moderate slopes, some patches have a decided reddish cast, a feature which is characteristic of this soil throughout the greater part of its area. In some places the topsoil contains considerable coarse sand and gravel, derived probably from the associated gravelly areas.

Nuckolls silt loam is rather extensive in Nuckolls County. It occurs principally in the southern part along the tributaries of Republican River. Some areas are also along the tributaries of Little Blue River, and a very few scattered areas are in the southern hilly uplands.

This soil occurs chiefly on the lower valley slopes, the upper parts of which are in most places occupied by the Holdrege and Hastings soils. In some places, however, erosion has removed the overlying loessial soils and Nuckolls silt loam extends over the lower ridges and hilltops. In many places narrow strips of colluvial and alluvial deposits along the valley floors or on the lower valley slopes are included in mapped areas of Nuckolls silt loam.

The Loveland phase of the loess, from which this soil has developed, has not been studied extensively and is not well understood, but it is thought to represent a loess older than the one from which the Hastings and Crete soils have weathered.

Owing to its topographic position the surface drainage of Nuckolls silt loam is excessive or severe, and erosion is serious. About 20 per cent of the soil, including the more gradual slopes and less severely

eroded divides, is under cultivation. The remainder supports a good growth of the grasses common on the Hastings and Crete soils and is used for grazing and the production of hay. The soil is adapted to all crops common to the region, but the yields are a little less than those obtained on the better loessial soils of the uplands.

Methods of managing this soil are similar to those practiced on the principal upland and terrace soils, but the more progressive farmers endeavor to keep the soil in cover crops to prevent further erosion. No commercial fertilizer is used, but barnyard manure is applied and considerable sweetclover or alfalfa is grown to increase the organic-matter content of the topsoil, especially on the bare red spots.

BUTLER SILT LOAM

The topsoil of Butler silt loam has three layers similar to those in Crete silt loam, except that the lower or granular layer is somewhat thinner and in many places is more or less sprinkled with almost white floury silt. The light-colored silty sprinkling is scarcely noticeable in the upper part of the granular layer but becomes more abundant with depth and in some places may form a thin fourth layer of loose, floury, and commonly laminated silt beneath the granular material. The total thickness of the topsoil averages about 15 inches. The subsoil consists of two layers. The upper layer is very dark grayish-brown or black heavy, compact clay, similar in color, structure, thickness, and compaction to the claypan layer in Fillmore silt loam but lacking or containing very few of the round, black concretions characteristic in that soil. Any black concretions which may occur are much softer and smaller than those in the Fillmore soil. Few of them exceed one-sixteenth of an inch in diameter. The lower subsoil layer is the layer of lime accumulation. It begins at a depth ranging from 36 to 40 inches and is from 30 to 50 inches thick. The material is very similar in all its characteristics to the lime layer of Fillmore silt loam. Concretions, splotches, and specks of white lime are abundant in the upper 12-inch or 14-inch section, and the lower part contains more or less finely divided lime. The quantity of lime, however, decreases with depth, and this material is entirely lacking at a depth of 6 or 8 feet.

Beneath the lower subsoil layer is yellowish-gray floury siltlike material commonly called yellow clay but known by the State geologists as loess. This is the formation from which the soil has developed. No lime is present to a depth of 4 or 5 feet in the layer.

Butler silt loam is uniform throughout the area of its occurrence in Nuckolls County. It occurs only in small scattered areas, few of which exceed 10 acres in size, throughout the uplands in the northern part of the county. Most of the soil occupies shallow, basinlike depressions, locally known as lagoons or buffalo wallows.

Butler silt loam occurs in shallow basinlike depressions or extremely level areas throughout the uplands. It is the best of the comparatively poorly drained upland soils. It is transitional in structure and drainage conditions between Crete silt loam and Fillmore silt loam.

Drainage on this soil is variable. Surface drainage in most places is poorly established or absent, and the claypanlike upper subsoil layer restricts underdrainage. In wet years water often stands on

the land for periods ranging from a few days to several weeks after heavy rainfalls. However, the topsoil is thick enough in most places to absorb and store the moderate rainfall of average years, and the soil as a whole is better drained than Fillmore silt loam.

Owing to its small extent and uncertain drainage this soil is of little agricultural importance in Nuckolls County. Practically all of it is used for pasture or hay land. It is naturally strong and fertile, however, and in other counties, where natural drainage is better or the soil is sufficiently extensive to warrant the expense of artificial drainage, it is used for all crops common to the region. On adequately drained areas, crop yields equal or slightly exceed those obtained on Crete silt loam.

The native vegetation on this soil in Nuckolls County includes moisture-loving grasses and sedges in the lower situations and buffalo and grama grasses where natural drainage is better.

FILLMORE SILT LOAM

Fillmore silt loam occurs in shallow, basinlike depressions throughout the uplands. It has a darker and heavier claypan layer than any other soil in Nuckolls County. The topsoil is friable and ranges from 6 to about 14 inches in thickness. Where the topsoil is thinnest it is commonly composed of two layers. The upper layer is dark grayish-brown, semigranular heavy silt loam, 1 or 2 inches thick. The lower layer may be either almost black or light gray, depending on drainage conditions. Where the soil is well drained the layer is generally very dark, but where it is poorly drained it may be almost white. In most places it is laminated, or similar in structure to the third topsoil layer of the Hastings and Crete soils. Where the topsoil is thickest the two surface layers are both very dark and a third layer, varying from 3 to 10 inches in thickness, has developed. The latter layer is friable, imperfectly granular, and almost black silt loam in the upper part, but is more or less sprinkled throughout with white floury silt which becomes increasingly abundant with depth and which in many places masks the naturally dark color of the granules in the lower part. In the more poorly drained situations the white silt may be so abundant as to form a thin, generally laminated, fourth layer beneath the granular material. In few places does the fourth layer increase the average total thickness of the topsoil, as the third or semigranular layer is thinner in the poorly drained areas. The white floury silt somewhat resembles volcanic ash and is so called by many farmers. It has no abrasive qualities and is simply a product of soil weathering under poor drainage conditions.

Beneath the variable topsoil is the subsoil, consisting of two layers. The upper layer is black, dense clay varying from 12 to 24 inches in thickness. It is massive and structureless but on drying cracks into irregular lumps of various sizes. A few rust-brown stains are present in the upper part of this layer, and scattered throughout the material are black, hard, and round concretions which vary from one-eighth to slightly more than one-fourth inch in diameter and which have slightly pitted surfaces. The lower subsoil layer is characterized by its high lime content. It consists of structureless, grayish-brown silt, moderately compact in the upper part where it is in contact with the claypan, but becoming lighter in color and more flourlike with depth.

Visible lime, chiefly in the form of concretions, spots, and splotches, is abundant to a depth ranging from 8 to 12 inches in the layer, but it gives way to finely disseminated lime which is thoroughly mixed with the silt at a depth of about 5 feet beneath the surface. All traces of lime disappear at a depth of 6 or 7 feet.

Beneath the lower subsoil layer is the parent loess. This is yellowish-gray flourlike silt containing scattered rust-brown stains and spots. No lime is present to a depth of 4 or 5 feet in this material.

Except for the variations in the topsoil, areas of Fillmore silt loam are remarkably uniform throughout Nuckolls County. The light-gray floury silt layer, where well developed in the topsoil, may locally be stained with rust-brown streaks in the lower part, and may also contain numerous black concretions similar to those in the claypan layer. The immediate surface layer may contain a sufficiently heavy sprinkling of gray silt to give it a decided grayish cast. The variations mentioned are unimportant, and their distribution is not shown on the soil map.

Fillmore silt loam in Nuckolls County occurs only in scattered, shallow, basinlike depressions throughout the more nearly level uplands. The basins are locally known as lagoons or buffalo wallows.

Owing to the flat and basinlike position of the soil surface drainage is poorly established, and the claypan subsoil prevents free underdrainage. Water often accumulates in the depressions after heavy rains and disappears slowly through evaporation. The surface soil, however, is not so continuously moist as is that of Scott silt loam, and in many places the soil is sufficiently drained for some crop production. However, owing to its small extent and imperfect drainage, the land is of little value for cultivated crops, and practically all of it is pasture or hay land. Many of the smaller areas are included in cultivated fields of other soils, but they are regarded principally as waste land and are not cultivated.

Fillmore silt loam supports a variety of moisture-loving grasses in the lower areas and buffalo, grama, and wheat grasses on the better drained areas.

VALENTINE LOAMY SAND

The topsoil of Valentine loamy sand is brown or grayish-brown loose, loamy sand, 8 or 10 inches thick. The subsoil is incoherent gray or yellowish-gray sand lighter in color and coarser in texture than the topsoil. On low ridges and knolls, where conditions have not favored the incorporation of organic matter, the topsoil is very loose and incoherent, but in the pockets it is darker, contains a fair quantity of organic matter, and is rather coherent. The sand grains are chiefly quartz and feldspar. In general, both topsoil and subsoil are deficient in organic matter and very poor in lime. Usually the soil tends to blow where the protective covering of grasses is removed.

Valentine loamy sand is not extensive in Nuckolls County. The areas are small and widely scattered. They occur principally in association with rough stony land.

Areas of this soil are gently rolling. Drainage is largely subterranean and is good or excessive, as the loose porous sands afford ample outlet for all surplus water. The soil is unusually retentive of moisture, however, considering its loose structure, a feature which is characteristic of the Valentine soils.

This soil has weathered from exposures of sand which is finer in texture than the materials from which rough stony land has developed. Valentine loamy sand and rough stony land are so intermingled in Nuckolls County that small patches of Valentine loamy sand are included in mapped areas of the coarser material.

Valentine loamy sand is of little agricultural value in Nuckolls County, as it is subject to drifting and is inextensive. The few cultivated areas are planted to corn, but most of the land is used for pasture. The pastures support a fair growth of native grasses, chiefly bunch, buffalo, grama, and Indian grass. Little grass is cut for hay.

This soil is included on farms with larger acreages of other soils, and the value of a farm on which it occurs is slightly lowered.

SARPY LOAMY SAND

The topsoil of Sarpy loamy sand is light-brown or yellowish-gray loamy sand or sandy loam from 12 to 15 inches thick. The material is loose, friable, and very incoherent. It contains no organic matter and is poor in lime. The subsoil is practically identical with the topsoil in color and texture to a depth of 3 or 4 feet, but it becomes slightly coarser with increasing depth. Both topsoil and subsoil are incoherent in most places, but in a few small pockets or depressed areas the topsoil contains a fair quantity of silt and clay, which greatly increases its stability.

Numerous variations occur in this soil. In many places in the subsoil coarse layers alternate with fine-textured ones, and in places iron stains varying in color from rust brown to reddish yellow are common. Small areas of the sand, silt loam, and very fine sandy loam members of the Sarpy series are included in mapping. In some areas where the topsoil was left unprotected it has been removed by the wind and almost white, incoherent, fine or medium sand is exposed. A few small areas of river wash are also included with mapped areas of this soil. All of these variations, however, occur in small areas and are of slight importance.

Sarpy loamy sand occurs on the flood plains of Republican and Little Blue Rivers, in narrow elongated areas whose longer axes parallel the stream courses. The areas are rather large and are well distributed throughout the Republican River Valley. They are not continuous but are separated by areas of heavier soils. This soil was formed from coarse stream sediments deposited in periods of high water. Since the shallow currents had low transportation power, however, many pockets of heavier textured material occur within the larger areas.

Areas of this soil are flat or gently billowy and are characterized largely by a series of low ridges with intervening depressions. This soil resembles the Valentine soils of western Nebraska, and the native vegetation and cultural methods used on it are similar to those on the Valentine soils.

Owing to the porosity of the sands, drainage is excellent. As the water table lies near the surface, the soil is not droughty.

Sarpy loamy sand is rather important agriculturally, and about one-half of it is under cultivation. The remainder is used for pasture and hay land. The principal crops are corn, sorghum, and alfalfa.

Melons seem to flourish, and all truck crops, such as squashes, cucumbers, pumpkins, and tomatoes, grow well in favorable seasons, particularly where the land is thoroughly manured. On account of the lower organic-matter content of the topsoil, yields of grain on this soil are slightly lower than those obtained from other sandy soils of the bottom lands. The native vegetation consists largely of bluestem and sand grass. Sandburs, sunflowers, and cockleburs are common and troublesome weeds in both pastures and fields. Areas bordering the river channel support a fair growth of willow, elm, and cottonwood.

This soil is easily managed and cultivated, but its low organic-matter content makes it unstable and more or less subject to drifting. Manure is applied, but the supply is insufficient for best results.

In the utilization of this soil every possible means should be used to increase the organic-matter content. Plowing under green crops, planting legumes, and making heavy applications of barnyard manure will greatly increase the producing power. The land should be kept in cover crops as much of the time as possible, in order to prevent the soil from blowing.

SARPY GRAVELLY SANDY LOAM

The surface soil of Sarpy gravelly sandy loam is grayish-brown or light-brown, loose, incoherent, loamy sand which contains a high percentage of fine gravel. It is underlain by coarser sand and gravel of similar color.

This soil, which is very inextensive in Nuckolls County, occurs in two long narrow strips, one in the Republican River Valley in the southern part of the county and the other along a small tributary to Republican River in section 32, T. 1 N., R. 5 W. The soil occupies flood-plain positions and has developed from coarse sediments deposited by the streams during periods of overflow. The surface is flat. Drainage is excessive, owing to the porosity of both surface soil and subsoil.

Sarpy gravelly sandy loam has practically no value for grain production, and very little of it is cultivated. It has a very low content of organic matter, and crops suffer from lack of moisture during dry seasons. Most of the land is subject to overflow. Corn, watermelons, cantaloupes, and alfalfa are grown in some places, but the yields are usually low. The best use of this soil is for pasture land. The native growth of bunchy bluestem, sand grasses, and stipa or needle grass is scant, and the land does not have a high value even for grazing.

SOGN SILT LOAM

The topsoil of Sogn silt loam consists of three layers. The immediate surface layer is a structureless silt loam mulch, in few places more than 1 inch thick. This is underlain by very dark grayish-brown silt loam, 4 or 5 inches thick, which has a well-developed very fine granular structure. This material is loose, friable, and well filled with grass roots, but it does not have the laminated arrangement of the soil particles which characterizes the corresponding layer of the Hastings and Crete soils. As a rule the organic matter is fairly abundant, moderately decomposed, and thoroughly disseminated throughout the soil mass. The third layer, averaging 8 or 10 inches

in thickness, is similar in texture to the overlying layers but is marked by more perfectly developed granulation. It is composed of a granular mass of well-rounded, slightly lighter colored aggregates ranging from one-eighth to one-fourth inch in diameter. These aggregates have a faint reddish cast.

The subsoil is composed of two layers. The upper one is the layer of maximum compaction. The density, however, is low as the material remains friable with no suggestion of a claypan. This layer consists of heavy silt loam or silty clay loam of granular or small cloddy structure, the individual lumps ranging from one-fourth to three-fourths inch in diameter. The color is slightly lighter than that of the overlying layer, and the granules have a similar reddish cast. Between depths of 25 and 30 inches, the material is friable reddish-brown silt loam, lighter in texture than the overlying layer and without definite structure. This material breaks into rough, angular clods of various sizes and shapes and contains numerous filled-in wormholes and insect canals. This lower subsoil layer grades into loose fragmental material, containing small angular bits of limestone of the Niobrara chalk from which the soil has weathered.

Owing to the irregular surface relief where this soil occurs, it is lacking in uniformity throughout the county. On the more level areas, where erosion is not active, the soil largely conforms to the description given. There is wide variation, however, in both the thickness and color of the several layers and in the depth to the underlying rock. On very steep slopes, especially along the larger drainage ways, the soil is shallow, and in many places the underlying chalk lies within 10 inches of the surface or crops out. The surface dust mulch has been washed from many of the steeper slopes. As a rule the remaining surface layers have lost much of their organic matter and are much lighter in color than typical. Many of the fields in severely eroded areas are marked by light-gray or white spots, as the white calcareous material, or bedrock, lies only a short distance below the surface. Topographically this soil occupies a position intermediate between the higher uplands and the valley floors. On the upper slopes, therefore, the soil merges with loessial soils and in places has been so modified by silt that the boundary line between Sogn silt loam and the loessial upland soils has been more or less arbitrarily drawn.

Sogn silt loam, as mapped in Nuckolls County, includes all the areas of rough stony land adjoining streams which have cut into the Niobrara chalk and all the areas of deeper weathered soils derived from this formation. It occurs along nearly all the streams and major draws in the southwestern hilly uplands, in a few places along Republican River Valley, in Elk Creek basin south of Nelson, and here and there along Little Blue River. Most of it occurs in long, narrow strips along the valley sides but some of it extends for short distances into the eroded, loess-stripped uplands. Many of the narrower strips are not indicated on the soil map because they were too narrow to be accurately shown, but their occurrence is designated by rock-outcrop symbols.

The surface of this soil is strongly rolling along the larger outcrops and gently rolling along the upper slopes and divides. The soil is excessively drained, on account of the steepness of the slopes. Where water enters the soil, the slight depth to bedrock makes a shallow

local water table and soon causes a large part of the surplus water to escape as seepage or springs along the point of contact, where erosion has exposed the bedrock.

On account of its prevailing shallowness, droughtiness, and broken relief, this soil is rather unimportant agriculturally. Much of it is too rough and stony to be cultivated. With the exception of areas where the rock outcrops, the soil supports a good growth of native grasses. A small acreage of the grass is cut for hay, but most of the land is used for pasture. From 5 to 7 acres are usually required to pasture one animal. Small acreages of corn, sorghum, Sudan grass, and other forage crops are occasionally planted on the more nearly level areas or where Sogn silt loam is associated with higher soils. Neither the relief nor the character of this soil is favorable to the retention of moisture, and crop yields are apt to be discouraging even in normal years.

The drainage ways dissecting Sogn silt loam in the southwestern hilly uplands generally support a scant growth of elm, boxelder, ash, and cottonwood along their channels. The higher contact zone of Niobrara chalk and the mantle rock cause constant seepage from the water table, and many of the drainage ways carry water during part of the year or the water table lies so close to the surface as to be favorable to tree growth. In the southwestern hilly uplands the drainage ways are of twofold importance. They supply drinking water for the animals on pasture, either directly from their channels or through shallow valley wells, and the tree growth supplies the cattle with shade. The uplands of this part of the county have poor water-bearing formations, as the loess rests largely on the Niobrara chalk. Water is difficult to obtain, and its rather high iron content affects its taste.

LAMOURE SILT LOAM

The surface layer of Lamoure silt loam is 5 or 6 inches thick. It consists of brown or dark grayish-brown friable silt loam which contains rather large quantities of organic matter. The next layer continues to a depth of 12 or 14 inches. It is dark-brown or very dark grayish-brown silt loam or light silty clay loam, distinctly darker than the surface layer and slightly heavier in texture. Both surface and subsurface layers are friable and in many places are faintly granular. The subsoil consists of two layers, the upper of dark-gray or brownish-gray, compact, tough silty clay loam which continues to a depth ranging from 20 to 30 inches, and the lower of yellowish-gray or dark-gray silty clay or clay loam, which is distinctly lighter in color than the upper part. Rust-brown stains are numerous, and lime is abundant. The lime occurs chiefly in spots, splotches, and small hard and soft concretions. The presence of lime is the principal mark of distinction between the Lamoure and Wabash soils. The latter contain no limy material in their subsoils.

Lamoure silt loam is fairly uniform throughout the area of its occurrence in Nuckolls County. The surface layers may vary slightly in texture in different localities, and the subsoil layers in places contain alternating layers of sand and clay, but these variations are of local importance and of such slight extent that they do not warrant separation on the soil map.

This soil occurs in a few small areas on the first bottoms or flood plains of Republican River. Its total acreage is very small. The

surface is flat and shows only a slight gradient downstream and toward the stream channel. The largest area is in the western part of the valley. Most of the soil is included in pasture and hay land. It supports a rank growth of moisture-loving grasses which will pasture one cow or horse to the acre during the summer grazing season, or when cut for hay will yield from one-half to 1 ton to the acre, depending on the season.

Corn is the principal cultivated crop but is grown only in the better drained situations. The average yield under favorable conditions is about 35 bushels to the acre.

The utilization of this soil for cultivated crops depends on artificial drainage. The soil is naturally strong and fertile, has a high lime content, and when well drained is adapted to all crops common to the region.

SCOTT SILT LOAM

The topsoil of Scott silt loam is even more variable than that of Fillmore silt loam. It may vary from a mere film to a thickness of 12 or 15 inches. It is more or less laminated and in few places contains much granular material. The upper part is in most places dark or almost black silt loam and the lower part is grayish-brown or gray silt loam. In many places, however, the entire topsoil has a decided grayish cast and in the more poorly drained situations the lower part may be almost white, loose, laminated silt. Where the lower topsoil layer is unusually light in color it commonly contains scattered rust-brown streaks and numerous black, hard, spherical pellets or concretions from one-eighth to slightly more than one-fourth inch in diameter. In most places the topsoil is rather friable.

The subsoil consists of two layers. The upper layer is a true claypan, although it is in few places so extremely compact or so dark in color as the corresponding layer in Fillmore silt loam. It is steel-gray or bluish-gray heavy clay which contains numerous rust-brown stains and scattered black, hard, round, concretions similar to those in the claypan of the Fillmore soils. The claypan has no definite structure, varies from 18 to 40 inches in thickness, and continues to an average depth of 4 feet. The lower part of the subsoil is moderately compact grayish-brown or dark grayish-brown silty clay in the upper part. It becomes lighter in color and more friable with depth and is very light grayish-brown flourlike silt in its lower part. The subsoil merges with the yellowish-gray pulverulent silt of the parent loess at a depth of about 6 feet. The lower part of the subsoil is noncalcareous, and no lime is present in the parent loess to a depth greater than 8 or 10 feet.

Scott silt loam is remarkably uniform throughout the area of its occurrence in Nuckolls County. It occurs only in shallow depressions throughout the uplands. Few of the depressions exceed a few acres in size, and many of them are only a few square rods in extent.

This soil is more poorly drained than any other soil in the county. None of the depressions have natural surface drainage, and the claypan restricts underdrainage. Water which accumulates on the surface remains there until it is removed by evaporation. The land is unsuited to crop production, even in dry years, as the nearness of the claypan to the surface renders the soil droughty in seasons of unusually low precipitation. The soil is used almost entirely for

pasture or hay land. A few areas are included in cultivated fields, but most of these inclusions are regarded as waste land. The soil supports a rank growth of sedges, rushes, smartweed, and other water-loving plants in the lower places and of prairie grasses in the better drained parts of the depressions. Most of the vegetation, however, is so rank and weedy as to be of low feeding value when it is cut for hay.

Scott silt loam should probably be used almost entirely for pasture land. A few farmers have applied manure and straw to the depressions in an effort to increase the water-holding capacity of the soil and prevent surface accumulations of moisture. This procedure is of doubtful benefit, as the impervious subsoil is the chief deterrent in crop production.

ROUGH STONY LAND

Rough stony land consists principally of grayish-brown loamy sand which contains a high percentage of angular and rounded gravel and small cobblestones. In places, the admixture of gravel and similar coarse particles is small, but typically the surface of the material contains rounded rock and mineral particles varying from a fraction of an inch to several inches in diameter. The rocks are both basics and granites, and are composed largely of quartz with some feldspar. The subsurface layers consist of light-colored sand and gravel ranging from fine to coarse in texture. In places the subsurface materials are sufficiently uniform to be used for construction purposes.

Rough stony land includes areas of stony loam, fine sandy loam, and loam too small to map. Most of the coarser textured areas occur as knolls and the finer textured ones as pockets where conditions have favored the collection and retention of silt and clay particles.

Rough stony land in Nuckolls County occurs principally in the southwestern quarter and along drainage ways which empty into Republican River in the southern part. It occurs also on the lower valley sides of many of the main drainage ways which dissect the rolling central uplands and along a few of the smaller tributaries. The stony material also covers small divides, forming irregular chains of low pebbly hills along the valley trough.

The relief is rolling or hilly. On this account and because of the porosity of the land drainage is excessive. The soil is droughty and suited only for use as grazing land. Owing to the excessive drainage, the grass growth is scanty and poor. Buffalo, grama, and bunch grasses and an occasional yucca or soap weed form the vegetable cover.

The material of which this land is composed is probably derived from outcrops of the gravel and sand deposits which underlie the loess of the county and which are the principal water-bearing layers of the uplands. There are no prominent exposures of the gravel and sand in the southwestern hilly uplands where the loess mantle is thin and the water problem correspondingly acute. The outcrops along Little Blue River Valley are neither prominent nor numerous, although sand and gravel beds are found in many well borings. The rolling rounded hills occupied by rough stony land and the pebbly surface strongly resemble similar exposures in the valleys of Lodgepole Creek, North Platte River, and South Platte River in western Nebraska.

Because the material is derived largely from outcrops and because it occurs on valley slopes much of it is mixed with soil washed from the higher areas. Consequently, areas mapped as rough stony land include some material of much finer texture.

SUMMARY

Nuckolls County is in the southern tier of Nebraska Counties, just east of the mid-point on the Nebraska-Kansas State line. The area includes 579 square miles or 370,560 acres.

The general surface of the county is that of a plain, the greater part of which is dissected by stream valleys. The two larger streams, Republican and Little Blue Rivers, cut the upland of the county into three main divisions. These uplands are remnants of the flat loess plain which originally covered most of eastern and southern Nebraska.

Nuckolls County occupies a plain of unusual elevation, the average elevation of the uplands being about 1,800 feet above sea level. The slope of the county is southeastward. Republican and Little Blue Rivers, intrenched about 200 feet below the uplands, are the principal drainage ways.

The early settlers of this county came from eastern Nebraska and from many other States east of Missouri River. In 1920 Superior, the largest town, had a population of 2,719, and Nelson, the county seat, had a population of 955. The county contains several other towns, villages, or small trading posts with elevator facilities.

The climate of Nuckolls County is variable but healthful. Under average conditions, the precipitation and frost-free season are fairly adequate for economical farming.

Wheat is the principal crop on the flat uplands. Corn and hay are grown mainly on the central rolling uplands and on the river bottoms. The less important crops include oats, Sudan grass, sorghum, and wild hay. These are grown in all parts of the county as subsidiary crops to be used either as feed for work animals or for fattening beef cattle and hogs.

The soils of the county have three general characteristics. They are dark colored, are granular in structure, and have developed or are in the process of developing a layer of lime accumulation in the upper part of the subsoil. This last-mentioned characteristic distinguishes them from the humid soils of the United States, where there is no accumulation of carbonates.

Several groups of soils are recognized in the county. Each group is in turn made up of one or more series, the soils of which have reached various stages of development. The series are further separated into soil types on the basis of textural differences in the surface soils.

The most important group, with regard to total area and distribution, is that which occupies the smooth uplands and terraces. These soils are characterized by five layers: A dust mulch, a laminated layer, a granular layer, a layer of maximum compaction, and a layer of lime accumulation. The group includes soils of the Hastings, Crete, Butler, Fillmore, and Hall series. The Scott soils occupy depressed and poorly drained areas in the more level upland.

The soils of secondary importance occupy hill country. The fundamental characteristics of these soils have been acquired in the process of adjustment to sloping and rolling land. Soils of the Nuckolls, Sogn, and Holdrege series are included in this group.

The sands and gravels underlying the loess formation have given rise to the very immature, coarse-textured soils of the Valentine series and to areas of rough stony land.

Another group of soils occupies the flood plains. The fine and coarse sediments transported by the streams have given rise to soils of corresponding texture. Soils of the coarse-textured group, which includes members of the Cass and Sarpy series, have fair internal drainage. Soils of the fine-textured group, represented by members of the Wabash and Lamoure series, have poor underdrainage, but their surface drainage is generally adequate between overflows.



[PUBLIC RESOLUTION—No. 9]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]

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